THE SEA-MANS PRACTICE,

Containing

A FVNDAMENTAL PROBLEME in Navigation,

Experimentally verified:

Namely,

Touching the Compaſſe of the *Earth* and *Sea*, and the quantity of a Degree in our *Engliſh* meaſure.

ALSO,

An exact method or form of keeping a Reckoning at Sea, in any kind or manner of Sailing.

With certain Tables and other Rules uſeful in *Navigation. As alſo in the Plotting and Surveying of places.*

The Latitude of the principal places in ENGLAND.

The finding of Currents at Sea, and what allowance is to be given in reſpect of them.

The Fifth Edition.

By *Richard Norwood*, Reader of the *MATHEMATICKS.*

LONDON,
Printed by *William Leybourn*, for *George Hurlock*, and are to be ſold at his ſhop at St. *Magnus* Church-corner, in *Thames* Street, neer *London* Bridge, 1662.

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To the Right Honourable

ROBERT,

Earl of *WARWICK*,

Baron of *LEES*, &c.

Right Honourable,

ALthough the knowledge and practice of the Art of Navigation be of late years grown to a far greater Perfection, then it can appear to have had in any former Age, and by that means, the World and all the parts thereof have been further discovered, yea, Sailed round about: the Traffick and Entercourse of several Nations, how remote soever, facilitated. Knowledge in divine and humane things divulged: and (which as I conceive is of most importance, seeming as yet to be the principal scope of the Divine Providence in discovering these Mysteries) the light of the glorious Gospel of *Christ*, being the mighty power of God unto Salvation, is extended to those silly Captives of Sathan in *America*, by means of those many Plantations we have amongst them: which Plantations (even from their first breathing) have received no small furtherance from your Noble favour and bounty, as I know by my own Experience in that where sometimes I was, and have understood no lesse by others in the rest.

Yet notwithſtanding this notable growth and daily exerciſe of the Art of *Navigation*, it ſtill remains imperfect in ſome points. For whereas the practice thereof doth eſpecially conſiſt in the knowledge of Latitudes, Courſes, and Diſtances; the way of finding diſtances at Sea, namely, by the Log and Line, is rather opinionative and conjectural then certain, being grounded upon this ſuppoſition, that the compaſſe of the World in any great Circle is 21600 *Italian* miles (as they call them) and that ſuch an *Italian* mile contains 1000 Paces, and every of thoſe paces five *Engliſh feet*: and according to theſe meaſures they divide their Log-line, and keep their account of the ſhips way at Sea.

Having therefore by an Experiment which I made a year ſince, found more neerly the compaſſe of the Earth, and the quantity of a Degree on the ſame in our known meaſures, and applyed it to uſe in *Navigation*, in this Treatiſe following: and further added ſome other things as I conceived to be wanting in the practice of that Art: I have preſumed to preſent it to your Lordſhip, aſwel becauſe by your knowledge in *Navigation*, and the experience you have had in your Honourable enterprizes at Sea, you are well able to judge of it: as alſo being confident that according to your noble diſpoſition you will favourably accept thereof, though otherwiſe of it ſelf unworthy. The moſt High God ever bleſſed and glorious, multiply unto your Honour all his bleſſings in *Chriſt Jeſus*.

Your Honours in all due Obſervance,

Richard Norwood.

To the Reader.

THe Circuit of the Earth and Sea (as the circumference of every Circle) contains 360 Degrees, by which degrees the diſtances thereon are meaſured, ſo that the knowledge of the quantity of ſuch a Degree in our known meaſures, is a fundamental principle in Coſmography and Navigation, as upon which is grounded the reckoning of the ſhips way or diſtance run. For though a Mariner being in his Voyage on the vaſt Ocean, have ſometimes three things to certifie him where he is, and how to ſhape his Courſe to his deſired Port, namely, his Latitude, Courſe and Diſtance, and ſometimes a fourth; namely, ſome neer conjecture of his Longitude by the Variation, or otherwiſe; yet oftentimes (as in cloſe weather) he hath nothing but his courſe and diſtance; otherwiſe onely his Latitude and Diſtance is his chief guide in falling with his intended Port. I know it is uſual to allow neer 7 Fathoms $40\frac{2}{3}$ feet to a knot, and ſo many of thoſe knots as runne out in half a Minute, ſo many miles they account the Ships way to be in an hour. And if in half a minute ſhe run $41\frac{2}{3}$ feet, then in 60 minutes or an hour ſhe runnes 5000 Feet, and thus they account 5000 Engliſh feet, or 1000paces to be a mile, and 60 of thoſe miles to be a Degree, ſuch as the whole circumference in any great Circle is 360. But how is this known to be true? If it be anſwered, that it is known to be ſo by Experience, then I would know further by what Experiment this was found to be ſo? Where, and by whom made? I preſſe this ſo much the rather, becauſe I am perſwaded we have at this day as many excellent Navigators in this Kingdome, and as great Voyages performed, as from any other place in the world, and I ſhould be glad to hear of the experimental reſolution of this Problem by ſome of them, though it were but in running eight or 10 degrees neer the Meridian: for ſo I doubt not but that which I have here written thereof would receive further confirmation and better entertainment then haply it will now, being ſo much different from the common opinion, and the Arts of Navigation and Coſmography would be much more perfected in ſhort time. For one errour (as a fruitful Mother) is oftentimes the cauſe of more, and ſo the removing of one is the occaſion of removing others, eſpecially, when they do mutually ſupport one another: As we ſhall here ſhew how the Errour in the Projection and uſe of the Common Sea chart, is ſupported by this Errour of accounting onely 300000 of our Feet to a Degree; and this in like ſort upheld by that, ſo that they will ſtand or fall together. And ſurely that had fallen long ſince, being ſo manifeſtly convinced; if it had not been upheld by this: For the confuting of that, (I mean the common Sea-chart)

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it was ſufficient to know that the Earth and Sea make one Spherical body, but in diſproving and rectifying this, it is neceſſary to know moreover what is the quantity of that Spherical body: and to that end it was neceſſary to make a ſenſible application of our known Meaſures, to a determined part of the whole, that ſo the quantity of that determined part being known, and the proportion thereof to the whole, the quantity of the whole might alſo be diſcovered. And this I have endeavoured in the experiment following, which if I have not handled ſo exactly in all points as ſome would deſire: That requiring more time and charge (then I could well beſtow) yet I doubt not but it will be found that I have come very neer the Truth. Some haply will cenſure me, for being my ſelf at the Expence to make ſuch an Experiment. But I was as frugal in it as I could, adding pains and induſtry to ſave expence, I came up in ten or eleven dayes, and had other neceſſary occaſions to lead me from the one place to the other, and did this as a thing falling opportunely in my way. But indeed (as in all other parts of Learning) ſo in the Mathematicks, eſpecially in their application, or middle Mathematicks (as ſome call them,) it is neceſſary with Speculation to joyn Actual and Experimental practices; the former being empty and uncertain without theſe. It is true, that the Mathematicks afford large fields of delightful Speculations, wherein a man might walk far with much pleaſure: But if from ſo many fair Flowers he bring home no honey, or from ſuch large fields no ſheaves: I mean, if he bring not thoſe Speculations to ſome uſeful practices, neither himſelf nor others are like to receive much fruit by them. But this indeed cannot be effected without more labour and difficulty, yea ſometimes it requires Mechanical and Bodily exerciſes, which ſome eſteem too mean and unworthy to ſtoop unto. But for mine own part, I acknowledge to have had my living and maintenance by the Mathematicks, and not by Speculation onely, but rather by my practice therein; and therefore alſo I deſire (what in me lies) to make them fruitful to my ſelf and others: And to that end have ſpent in ſome principal parts of the Mathematicks, neer as much time and means in ſome experimental Practices and Concluſions, as in the Speculation. Moreover, conſidering that this particular Experiment was propoſed above thirty years ſince, by our Country-man Mr. Edward Wright, *to invite ſome to the trial of it, as a thing which he would have done himſelf, if he had found ſuch furtherance and opportunity as he deſired, which it ſeems he did not, nor any other ſince that time: Rather then ſo noble and ſo neceſſary a* Problem *ſhould longer reſt unreſolved, I took the opportunity offered, hoping it may be an occaſion to whet on ſome others to do the like. This with ſome other things which I conceived to be wanting in the practice of Navigation, I have handled in this enſuing Treatiſe, which I commend to your friendly acceptance, Farewell.*

July the firſt, 1636.

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THE SEA-MANS PRACTICE.

CHAP. I.

The common Opinion touching the Compaſſe of the Earth, and quantity of a Degree of the ſame.

IT is a common received opinion in *England*, (and the like in other places) that allowing 5 of our *Engliſh* feet to a Geometrical pace, 1000 of thoſe paces make an *Italian* mile, and 60 of thoſe miles in any great Circle upon the Spherical ſurface of the Earth or Sea make a Degree; and thus it is ſuppoſed, that a Degree contains 60 miles, or 60000 paces, or 300000 of our *Engliſh* feet, and by ſuch miles do Mariners in their Voyages by Sea keep their Reckonings: And becauſe the whole circumference of a Circle is 360 Degrees: therefore the compaſſe of the Earth, according to this opinion ſhould be 21600 ſuch *Italian* miles, or 21600000 paces, or 1080000000 of our *Engliſh* feet. Whence this opinion came, or upon what opinion it ſhould be grounded, I cannot certainly ſay; It may ſeem to be taken, or rather miſtaken

miſtaken from *Ptolomy*, who ſaith, there are 500 *Stadiums* in a degree, the ſame was before affirmed by *Marinus Tyrius*, of whom *Ptolomy* ſpeaking in the 11 Chapter of his Book of *Geography* hath theſe words, *Sed in hoc quoq; recte ſentit partem unum qualium eſt circulus maximus tricentorum ſexaginta, quingenta in terra conſtituere Stadia, id enim confeſſis dimenſionibus conſonum exiſtit.* Now a *Stadium* not onely amongſt the *Greeks*, but as appears by *Herodotus*, amongſt all other Nations of *Aſia* and in *Egypt*, did conſiſt of 620 feet, or 100 *Orgyas*, an *Orgya* conteining ſix feet or four cubits as our fathom doth: the ſame is alſo teſtified by *Suidas* and others: So that a Degree containing 500 Stadiums, and every Stadium 600 feet, it follows that a Degree muſt contain 300000 feet, exactly agreeing in number with the common received opinion in *England*, which therefore may ſeem to be hence derived, and would alſo receive much confirmation hereby (he being an Authour of ſuch approved credit) if it could be approved that our *Engliſh* feet were exactly equal to the *Egyptian* or *Alexandrian* foot, where *Ptolomy* wrote. Otherwiſe that being true, that ſo many of their feet make a degree, it will follow, that if ours be greater, there be fewer of them contained in a degree; if leſſer (as undoubtedly they are) there muſt be more of them contained in a Degree.

Philander in his Commentary upon the third Chapter of the third Book of *Vitruvius*, hath expreſſed the quantity of the ancient *Roman* foot, where (by a competent allowance for the ſhrinking of the paper being printed wet) it may probably be gathered that it was ſomething longer then our Engliſh foot. But the *Alexandrian* and *Egyptian* foot was much greater, for according to *Hermochanicus*, 5 *Alexandrian* feet were equal to ſix *Roman* feet: ſeeing then the ancient *Roman* foot was ſomething greater then ours, the *Alexandrian* foot muſt needs be much greater then ours. So that whereas *Ptolomy* ſaith there are 500 *Stadiums* in a degree, & as we have ſhewed a *Stadium* did conſiſt of 600 feet, theſe being *Egyptian* or *Alexandrian* feet, as it is moſt probable, being the place where *Ptolomy* lived; there muſt be a far greater number of our feet in a *Stadium*, & ſo in a degree, whence

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it is evident, that there is no ſufficient footing for this common opinion in the aſſertion of *Ptolomy*.

Neither doth the practice and experience of Mariners in their Voyages at Sea prove it; for there is no reckoning or experiment at Sea ſet down by any (that I have ſeen) to confirm it: And though it be true, that in ſayling between two places that lie neer to one and the ſame Parallel, they ground their reckoning chiefly upon this ſuppoſition, that 300000 of our Engliſh feet make a Degree, yet can they ſeldome or never by thoſe reckonings diſcern the Errour, the rather for that they have been, and for the moſt part are ſtill kept upon the Plain or Common *Sea-Chart*, which makes a Degree in any Parallel equal to a Degree in the Equinoctial; and ſo makes a Degree in any Parallel to contein 300000 feet: And it is true, that in ſome Parallel a Degree doth contein onely 300000 of our Engliſh feet; namely, about that Parallel which is in Latitude 35 degrees (as we ſhall further ſhew hereafter) neer unto which have the principal of our Eaſtern and Weſtern Voyages been made. And thus though this opinion of 300000 feet in a Degree, and the projection of the *Common Chart* be both erroneous, yet becauſe the errour of the one doth ſomething ſalve the other, they could not be ſo eaſily diſcerned by Experience onely.

This opinion of 300000 Engliſh feet to a Degree, may ſeem alſo to be ſomething confirmed by an Obſervation made by our Countrey-man *Maſter Edward Wright*, upon *Mount Edgecombe* neer *Plimouth*, of the Semidameter of the Earth, which he hath ſet down in his Book, *Of the Correction of Errours in Navigation*, Chap. 15. where he findes the *Semidiameter* to be 18312621 of our Engliſh feet, whence it may be gathered, that in a degree of a great Circle of the Earth, there ſhould not be full out 300000 of our feet; but the way by him then uſed, though it was very fit for the end whereunto he there applies it; namely to finde the dipping or depreſſion of the apparent Horizon beneath the true, according to the heighth of the eye above the water; yet will it eaſily be granted to be

no exact way for finding the *Semidiameter*, and conſequently the Circumference of the Earth, or the quantity of a Degree on the ſame, and ſo he ſayes there, that he uſed that way, becauſe he wanted opportunity to put it in practice a more exact way. Wherefore for the further Satisfaction of my ſelf and others in this Point, and chiefly for the neceſſary uſe it hath in the Practice of *Navigation*, I have made the Experiment following, that ſo the quantity of a Degree, and of the whole Compaſſe of the Earth might at leaſt-wiſe be neerly known in our Engliſh meaſures.

CHAP. II.

An Experiment made for finding the quantity of a Degree, and ſo of the Circumference of the Earth and Sea in our known meaſures.

HAving occaſion to be in the City of *York*, about the beginning of *June*, *Anno* 16 5. I made there ſeveral Obſervations of the Meridian Altitude of the Sun, the laſt of which was made the eleventh day of *June*, the skie was every of thoſe dayes ſomething over-caſt at noon, yet not ſo much but that an Obſervation might be made to a neer ſcantling: And becauſe the laſt of theſe Obſervations is moſt fit for the preſent occaſion, and that day was as clear as any of the other, we will here eſpecially make uſe of that, being as followeth.

Upon the eleventh of *June* 1635. I made an Obſervation neer the middle of the City of *York*, of the meridian Altitude of the Sun, by an arch of a *Sextant* of more then five foot Semidiameter, and found the apparent Altitude of the Sun that day at noon to be 59 degrees 33 minutes.

I had alſo formerly upon the eleventh day of *June*, *Anno* 1633. obſerved in the City of *London*, neer the Tower, the appa-

apparent meridian Altitude of the Sun, and found the ſame to be 62 deg. 1 min.

And ſeeing the Suns declination upon the eleventh day of *June* 1635, and upon the eleventh day of *June* 1633, was one and the ſame without any ſenſible difference; and becauſe theſe Altitudes differ but little, we ſhall not need to make any alteration or allowance, in reſpect of Declination, Refraction, or Parallax: Wherefore ſubſtracting the leſſer apparent Altitude; namely 59 degrees 33 minutes, from the greater 62 degrees 1 minute, there remaines 2 degrees 28 minutes, which is the difference of Latitude of theſe two Cities; namely, of *London* and *York*.

Alſo by the aforeſaid Obſervation made in *York*, it appears, that the Latitude of that City is 53 degrees 58 minutes almoſt.

But to our purpoſe, comming at that time from thence to *London*, I further found by meaſure, that the Parallel of *York* is from the Parallel of *London*, 9149 Chains; every Chain being ſix Poles- and every Pole 16½ of our Engliſh Feet; that is, every Chain ninety nine Feet. (After what manner I found this to be ſo, we ſhall further expreſſe hereafter:) But thus, as I ſay, I found that *York* is more Northerly then *London*, by 9149 Chaines: And before, we have noted that theſe two places differ in Latitude 2 degrees 28 minutes: therefore it follows, that 2 degrees 28 minutes of the meridian on the Earth and Sea, is equal to 9149 Chains. And if accordingly we would know how many of theſe Chains are contained in one Degree, we may finde that by the Rule of Proportion, firſt reducing the Degrees into minutes, and then ſay,

If the difference of Latitude	148	*co. ar.*	7.82974
give ſuch a number of Chains.	9149		3.96137
Then one Degree, that is	60		1.77815
gives of ſuch Chains	3709		3.56926

and ſomewhat more, namely, five Feet, which reduced into Feet, make 367196; that is, 367200 Feet in a Degree, lacking four Feet, which here we regard not.

Thus then according to this Experiment, it is evident that one degree of a great Circle measured on the Earth, is neer 367200 feet, which in our Poles of $16\frac{1}{2}$ feet, is 22254 poles, and about one half, and these reduced into Furlongs, at 40 poles to the Furlong, make 556 Furlongs and 14 Poles; and lastly, these reduced into our English miles of eight Furlongs to a mile, make 69 miles, and 4 Furlongs, 14 Poles, that is $69\frac{1}{2}$ miles, and 14 Poles to a Degree.

And hence according to the next approved *Hypothesis* of the *Sphericity* of this *Terrestrial Globe*, we may finde the compasse of it, as followeth. But first, you may note, that we speak not here of the compasse of the Earth in any Parallel or lesser Circle described upon any side thereof (that being various according to the different distance of those Circles from their Poles) but of the Compasse taken in the middle or greatest thicknesse of the Globe, namely, in any great Circle, such as divide the whole Globe into two equal parts, of which kinde are the Equinoctial and all Meridians, &c. this being properly the *Perimeter*, or Compasse of a *Spherical Body*.

Now seeing a Degree is the 360 part of the circumference of a Circle (for any Circumference being divided actually, or by supposition into 360 equal parts, those parts are called Degrees) if we can finde how many Feet, Paces, Miles, or other known measures are contained in one of those Degrees, then shall we easily conclude how many of the same known measures are conteined in the whole Circumference: But by the former Experiment we finde, that in one Degree of a great Circle on the Spherical Superficies of the earth, there is contained 367200 Feet; therefore it is evident, that 360 times 367200 feet is the Compasse of the whole; wherefore multiplying 367200 by 360, the Product is 132192000 feet, which reduced into Poles, is 8011636, and these reduced into Furlongs, are 200290 Furlongs 36 Poles; and lastly, these reduced into miles are 25036 English miles, and somewhat more for the circuit of the Earth and Sea.

If further we desire the Diameter and Semidiameter of the Earth

Earth, forasmuch as it is proved by *Archimedes*, that the proportion of the circumference of a Circle is to the Diameter thereof, almost as 22 to 7: Therefore by the Rule of Proportion, As 22 to 7; So is the Circumference of the Earth, to the Diameter thereof: So that multiplying the Circumference of the Earth, namely, 132192000 feet by 7. and dividing the Product, namely, 925344000, by 22 the quotient, namely, 42061091 is the Diameter of the Earth in Feet, the half whereof, namely, 21030545 feet, is the Semidiameter of the same, being 21 millions of feet, and somewhat more: these reduced into English miles, as before we did the Circumference, shew the Diameter of the Earth to be 7966 miles, and somewhat more, and the Semidiameter 3983. And thus we have the Circumference, Diameter, and Semidiameter of the Earth, as also the quantity of a Degree of the same Circumference in known measures of Feet, Furlongs, and *Miles*, &c. There are onely two things here, which may seem doubtful; namely, the Experiment it self, and the *Hypothesis* of the Sphericity of this *Terrestrial Globe* consisting of the Earth and Sea, for these being admitted, the measures thence deduced as before, will necessarily follow.

Now touching the Experiment, I confesse, that to have made it so exactly as were requisite, and in all points so as I shall shew in the Chapter following, would have required much more time and expence then mine ability would reach unto; Yet having made Observation at *York*, as aforesaid, I measured (for the most part) the Way from thence to *London*, and where I measured not, I paced; (wherein through custome I usually come very neer the truth) observing all the way as I came, with a Circumferentor all the principal Angles of position or windings of the way, (with convenient allowance for other lesser Windings, Ascents, and Descents) and these I laid not down by a Protractor after the usual manner, but framed a Table much more exact and fit for this purpose, as we shall after after shew; so that I may affirme the Experiment to be neer the truth.

Touching

Touching the *Hypotheſis* that the Earth and Sea make one Spherical or round Body, it is generally agreed upon by all the Philoſophers, Aſtronomers, Geographers, and Navigators, ancient and modern, ſome reaſons demonſtrative for the confirmation thereof may be theſe.

Firſt, the Eclipſes, eſpecially of the *Moon*, which are cauſed by the ſhadow of the Body of the Earth being interpoſed between the Sun and the *Moon*, and as much as this ſhadow doth fall upon the *Moon*, alwayes and on every ſide circular, and ſo appears to us, it is manifeſt by the Opticks, that the Earth from whence it proceeds is a Spherical Body.

Secondly, likewiſe the Eclipſes of the Sun, which are cauſed by the interpoſition of the *Moon* between the Sun and thoſe places where it appears Eclipſed; I ſay it could not be determined when and in what place ſuch an Eclipſe ſhould appear, and where not, if the form of the Earth were not known; but ſeeing the places where ſuch Eclipſes happen, and where not, may be and are uſually determined, and that upon this ground; that the Surface of the Earth is Spherical, it is thence alſo ratified to be a truth.

Thirdly, the Sun, *Moon*, and Stars do riſe and ſet, and are upon the *Meridian* ſooner to thoſe that are reſident in the Eaſtern parts, then to others more Weſterly, and that in a proportion anſwerable to the roundneſſe of the Earth, as the Planets and Stars are upon our *Meridian* at *London* ſooner by almoſt four hours, then they are to thoſe that inhabit *Summer Iſlands*, and the confines of *Virginia* and *New England*: And ſo in *Eaſt-India*, and other Eaſtern Regions, the Sun and Stars are ſooner upon their *Meridian* then upon ours, which is manifeſt to be ſo, as by other reaſons, ſo eſpecially by the Eclipſes of the *Moon*: for an Eclipſe of the *Moon* hath not in it ſelf any diverſity of time, being at one and the ſame inſtant without reſpect of places, yet becauſe in the Eaſtern parts the day is begun, and it may be far ſpent before it begin in places farre Weſterly, therefore ſuch an Eclipſe may appear to the Eaſtern Inhabitants towards the end of their night, which to the Weſtern appears

pears in the beginning or middle of the ſame night with them, and ſo the difference will be more or leſſe, according to the different diſtance of thoſe places in Longitude.

Fourthly, furthermore we ſee, that going or ſayling to the Northwards, we have the Artick Pole and Southern Stars more elevated, and the Antartick Pole and Northern Stars more depreſſed, the Elevation Northerly increaſing equally, with the depreſſion Southerly, and either of them proportional to the diſtances which we go: the like happeneth in going to the Southwards. Beſides the Oblique Aſcenſions, Deſcenſions, Occultations, Emerſions, and Amplitudes of Riſing and Setting of the Sun and Stars, in every ſeveral Latitude, agreeable to the *Hypotheſis* of the Earths Sphericity. All which could not be ſo, if the Earth were of any other then of a Spherical forme.

Fifthly, ſo if we ſtand upon the Sea-ſhore, and ſee a ſhip farre off under ſail making towards the Land, at firſt we ſee onely the Top ſail's or higheſt parts, and withal do manifeſtly behold the convex Superficies of the Sea, as it were raiſed and interpoſing it ſelf between our ſight and the Hull or lower parts of the Ship, till ſhe approacheth neerer, and this uniformely, every wayes alike, and proportionably to the ſeveral diſtances which evidently demonſtrate the Spherical roundneſſe thereof.

Sixthly, And laſtly, (to adde no more) the Navigations of theſe later times make it apparent, thoſe eſpecially that have been made round about the World, as thoſe two Voyages by our famous Countrey-men Sir *Francis Drake* and Mr. *Thomas Candiſh*, both which ſeverally ſayling from our Coaſts to the *Weſt-Indies*, and paſſing the ſtraights of *Magellane*: continued their courſe Weſterly, till they came into thoſe parts, which are from us to the Eaſtwards; namely, to the *Eaſt-Indies*, and ſo ſailed ſtill Weſterly till they came to *Cap bon Eſperance*, and thence returned into *England*, having ſailed about the whole Terreſtrial-Globe, they found nothing by their Obſervations or reckonings diſſonant from the uniforme *Spherioity* thereof in

in all its parts. That they came ſhort in the number of dayes, one, or reckoned the time of their abſence leſſe by one day and a night then they which remained at home, this further confirms the thing in hand.

Yet whilſt we ſpeak here of the Roundneſſe of the Earth and Sea, we intend it not ſo ſtrictly as if it were a thing turned round without any inequality in its Superficies: But as a Bowl or Ball, though it have ſome duſt or ſmall grains of ſand cleaving thereto, may ſtill be ſaid to be round. So though the Lands, Hills, and Mountains be ſomewhat raiſed above the Spherical Superficies of the Sea, and if there ſhould be alſo ſome Valleys or bottomes more depreſſed; yet ſeeing the greateſt of theſe inequalities have ſcarce any ſenſible proportion to the Whole, we may well affirm the Whole to be round.

The relations made of the prodigious height of ſome Mountains, as to be 60 or 70 miles high, if it be underſtood of their perpendicular or direct height are fabulous; the Mount *Atlas* is recorded by ſome of the Ancients, to reach up almoſt to the Moon, and to be as it were a Piller for the Heavens to reſt upon, being meaſured Geometrically by *Eratoſthenes*, the perpendicular or upright height from the top thereof to the Valleys beneath, was found not to exceed ten *Stadiums*, which of our Engliſh meaſures is little more then a mile and a quarter, a *Stadiam* not much differing from our Furlong, and the like might be ſhewed of others.

But if we admit the higheſt mountains to riſe perpendicularly above the Spherical Superficies of the Sea two miles, yet ſeeing the Diameter or whole thickneſſe of the Earth, is as we have before ſhewed 7966 miles, this exorbitancy or difference of two miles is of ſmall moment; yea, if there were any mountain eight miles in height upright, yet this compared with the whole thickneſſe of the Earth, is little more than one thouſand part thereof; therefore we may conclude, that this *Terreſtrial Globe*, conſiſting of the Earth and Sea is *Spherical*. We come in the next place to ſhew by what way of meaſuring we found the Parallel of *York* to be diſtant from the Parallel of *London*,

9149

9149 Chains. And ſo how the diſtance of the Parallels of two Places may be exactly meaſured.

CHAP III.

A moſt exact way for finding the quantity of the Diameter and Circumference of the Earth and Sea, and of a Degree on the ſame.

I Do the more fully ſet down the way of making this Experiment, that ſo I may give occaſion to any who are ſo nobly minded for a publique good, as to be at that charge to make a further and more exact triall thereof. Now then the beſt and perfectest way is, to obſerve ſo exactly as may be the Summer *Solſtitial Altitudes* of the Sun at two places, ſo farre diſtant aſunder, and lying ſo near North and South each from other, with ſo direct and fair a way between them, as conveniently may be choſen: Suppoſe for example *Chriſt-Church* and *Berwick*, or ſome other place in the furtheſt parts of *Scotland*, for the further theſe two places are each from other: the more perfectly may this buſineſſe be performed. Then meaſure as truly as is poſſible, and ſet down in a Book, all the way between thoſe two places, with all the Windings, Aſcents and Deſcents that are therein, whereby with help of the inſuing Table, you may eaſily and exactly finde how much the one place is more Southerly then the other. For this purpoſe the *Plain Table* is not the fitteſt Inſtrument, but rather a *Theodolite* or *Peractor*, or ſome other of that kinde, obſerving diligently the Variation of the Needle. The Chain may be ſix poles long, or rather 100 feet, & the Table fitted accordingly (but the Table following is for poles) if it ſhould be much longer, it would be too heavy.

The High-wayes are commonly crooked, yet becauſe of ſundry obſtacles and impediments which are incident out of the way, and becauſe a man cannot certainly at firſt direct himſelf the neareſt and beſt way to the place intended, it would be expedient

pedient to measure the distance as aforesaid; First, in the Highwaies, leading from the one to the other, and then in the nearest and best way that could be chosen between them, and so if any notable Errour happen in the one, it may be discovered and amended in the other. The form which I observed in setting down the measures and angles, was according to this Example.

Deg.		*Distance.*	*North.*	*South.*	*East.*	*West.*
SE	31					
SE	20					
SE	13					
SE	13					
SW	02					
SE	05					

It is to be understood, that the Table here following was before calculated to serve instead of a *Protractor*, for a Circumferentor, or other Graduated Instrument, and for a Chain of three Poles, which for the most part I use; yet it may very well be applyed to a Chain of six Poles, (as in this business it was) reckoning every Chain to be two, &c. And thus for every ten Chains of six Poles to a Chain I make two stroaks, signifying two Changes or 20 Chains, and if there be any odde Chains, for those I set a figure in another line next below; and if moreover any odde Poles, whether one or two; for those I set another figure in a third line below.

Thus the last entrance before-going, being *SE.* 05 Degrees, ||||||||| signifies that the Line upon which I went,

5
2

was from the South-part of the *Meridian* to the Eastwards, making

king an angle with the *Meridian* of 5 Degrees, the nine ſtroaks ſignifie nine Changes, or ninety Chains, the figure 5 ſignifieth five Chains, and the figure 2 two poles. So that it is to be read thus; South-Eaſterly 5 Degrees, 9 Changes, 5 Chains, and 2 Poles; and the like is to be underſtood of the reſt. But for the moſt part having liberty of ground, I end the meaſure of every line, either with a whole number of Changes, or at leaſt of Chains.

And thus proceeding all day, towards the Evening, or when elſe I have time convenient, I reduce all theſe Diſtances, upon what Lines or Angles ſoever they be, to Diſtances of *North* or *South*, *Eaſt* or *Weſt*, as here appears.

Deg.	*Diſtance.*	*North.*	*South.*	*Eaſt.*	*Weſt.*
			2571	1545	
S E 31					
			2819	1026	
S E 20			1692	616	
			0169	062	
S E 13			2923	675	
S E 13			1754	404	
			1499		052
S W 02			2690	235	
S E 05			0149	013	
			0020	002	
Chaines.	571		16286	4578	052
	2		0	52	
Poles.	1715		16286	4526	

We will explain the laſt, and ſo the reſt may eaſily be underſtood: *S E.* 5 deg. ||||||||-5.2. here becauſe I have *S E.* the numbers taken out of the Table muſt be put into the Columns entituled *South* and *Eaſt*. Then in the Table under 5 deg. I look for 9 Changes, and finde againſt it 2690, and in the adjacent col. under the compl. thereof 235, and becauſe *S E* 5 deg. is leſſe then 45 deg. that is nearer to the South then to the *E.* I put in the col. entituled *South* 2690, and in that entituled *Eaſt* 235; then again

in the ſame Tabular Column under 5 degrees, I finde againſt 5 Chains, (cutting off a Figure; becauſe 5 Chains is but the tenth part of 5 Changes) 149 to be put in the *South* Column, and 15 for the *Eaſt* Column.

Laſtly, againſt 2 poles I finde for the *South* Column 20, and for the *Eaſt* 2, and the like is to be underſtood of all the reſt.

Now ſuppoſing this laſt to be a place, whoſe Diſtance and Situation from the firſt is required, I ſum up the Columns ſeverally and of the *North* and *South* Columns ſubſtract the leſſe from the greater, and ſo of the *Eaſt* and *Weſt* Columns; and ſo it will appear how much *North* or *South*, and how much *Eaſt* or *Weſt* the laſt place is from the firſt.

As in this Example, we finde the laſt place to be to the Southwards of the firſt 1628 Poles, for the laſt figure may be cut off, being uſed in the Table, onely for the more exactneſſe, or may be made a Fraction, and ſo it is $1628\frac{5}{10}$ Poles; Likewiſe the laſt place is to the Eaſtwards of the firſt $452\frac{5}{10}$ Poles, and thus I proceed all the way.

Now touching the angles of aſcent and deſcent of Hills and Valleys, to have obſerved them exactly, would have required more time and charge then I could of my ſelf beſtow; yet I made allowance for ſuch of them as were of moſt moment, he that would obſerve them all, may either make two or three Columns more, or keep an account of them apart by themſelves. But if he intend no further uſe of them, but to finde the neareſt diſtance, he need not ſet them down, but make allowance for them on the ground, keeping his diſtance intire without Fractions.

As admit I obſerve the aſcent from the Valley to the brow of a Hill to be 14 degrees above the Level or Horizontal Line, and that meaſuring, I finde the diſtance to be 30 poles; I turn to the Table, and under 14 degrees, and againſt 10 Chains, I finde 2911, and 726, ſhewing that the Level or Horozontal diſtance from my Station to that Brow is onely $29\frac{11}{100}$ Poles, and that the height of that Brow above the Level Line, is $7\frac{26}{100}$ Poles: But finding thus that the *Hypothenuſal* being 30, the

Baſe

Baſe or *level line* is but 29 $\frac{11}{12}$ that is leſſe by $\frac{89}{100}$ becauſe I would avoid this Fraction, I adde to the end of the foreſaid meaſure of 30 poles upon a level Line $\frac{89}{100}$ of a Pole, and then I may account my ſelf diſtant from the place in the Valley where I made Obſervation 30 Poles in a *Level* or *Horizontal line*, and ſo ſet down the diſtance without a Fraction: the like is to be underſtood of all other Aſcents and Deſcents.

Here followeth the Table.

	1 deg.	89 d.	2 d.	88 d.	3 d.	87 d.	4 d.	86 d.	5 d.	85 d.
1	300	5	300	10	300	15	299	21	299	26
2	600	10	600	21	600	31	599	42	598	52
3	900	15	900	31	899	46	598	63	896	79
4	1200	20	1200	42	1198	62	1198	84	1195	105
5	1500	26	1500	53	1497	78	1497	105	1494	131
6	1800	31	1799	64	1798	93	1796	126	1794	157
7	2100	37	2099	74	2097	110	2095	147	2093	183
8	2400	42	2398	84	2397	124	2394	168	2391	209
9	2700	47	2698	95	2696	140	2694	189	2690	235
10	3000	52	2998	105	2996	157	2993	210	2989	262
1	10	00	10	0	10	0	10	1	10	1
2	20	00	20	1	20	1	20	1	20	2

	6 d.	84 d.	7 d.	83 d.	8 d.	82 d.	9 d.	81 d.	10 d.	80 d.
1	298	31	298	37	297	41	296	47	295	52
2	597	62	596	74	594	84	592	94	590	104
3	895	94	894	111	891	125	889	140	887	156
4	1193	126	1192	146	1188	167	1185	187	1182	208
5	1492	157	1481	183	1485	209	1481	234	1477	260
6	1790	188	1787	220	1782	251	1777	281	1772	312
7	2089	220	2085	257	2080	292	2074	328	2069	365
8	2386	251	2383	292	2377	334	2371	375	2364	417
9	2686	282	2680	329	2674	376	2667	422	2659	469
10	2984	314	2978	366	2971	418	2963	469	2954	521
1	10	1	10	1	10	1	10	1	10	1
2	20	2	20	2	20	3	20	3	20	3

	11 d.	79 d.	12 d.	78 d.	13 d.	77 d.	14 d.	76 d.	15 d.	75 d.
1	295	57	293	62	292	67	291	73	290	78
2	590	114	586	142	584	134	582	146	580	156
3	883	172	881	188	876	203	873	219	870	233
4	1178	229	1174	250	1169	270	1164	290	1161	310
5	1473	286	1467	312	1461	337	1455	363	1449	388
6	1768	343	1760	374	1754	404	1746	436	1739	466
7	2068	401	2055	436	2047	472	2038	508	2030	543
8	2355	458	2348	500	2339	540	2329	580	2320	621
9	2650	515	2641	562	2631	608	2620	653	2610	699
10	2945	572	2934	624	2929	675	2911	726	2698	776
1	10	2	10	2	10	2	10	2	10	3
2	19	4	19	4	19	4	19	4	19	5

16 d.

	16 d.	74 d.	17 d.	73 d.	18 d.	72 d.	19 d.	71 d.	20 d.	70 d.
1	288	83	287	88	285	593	284	98	282	103
2	576	166	574	177	570	186	568	196	564	206
3	865	250	861	264	855	279	851	294	846	308
4	1153	332	1148	352	1140	371	1135	391	1128	411
5	1442	413	1434	438	1426	463	1418	488	1410	513
6	1730	496	1921	526	1711	556	1702	586	1691	616
7	2019	580	2008	615	1997	649	1986	684	1973	719
8	2307	663	2296	703	2282	743	2270	782	2255	822
9	2596	746	2583	791	2567	836	2552	880	2537	924
10	2884	827	2869	877	2853	927	2836	977	2819	1026
1	10	3	10	3	10	3	10	3	10	3
2	20	5	19	6	19	6	19	6	19	6

	21 d.	69 d.	22 d.	68 d.	23 d.	67 d.	24 d.	66 d.	25 d.	65 d.
1	280	107	278	112	276	117	274	122	272	127
2	560	215	556	224	552	234	548	244	544	254
3	840	322	834	337	828	351	822	366	816	381
4	1120	429	1112	449	1104	468	1096	488	1088	508
5	1400	537	1391	562	1380	586	1370	610	1360	634
6	1680	645	1669	674	1656	703	1644	732	1632	761
7	1960	752	1947	786	1932	820	1918	854	1904	888
8	2240	860	2225	899	2209	937	2192	976	2175	1015
9	2521	968	2504	1011	2485	1054	2466	1098	2447	1142
10	2801	1075	2782	1124	2761	1172	2740	1220	2719	1268
1	9	4	9	4	9	4	9	4	9	4
2	18	7	18	2	18	8	18	8	18	8

	26 d.	64 d.	27 d.	63 d.	28 d.	62 d.	29 d.	61 d.	30 d.	60 d.
1	270	131	267	136	265	141	262	145	260	150
2	540	263	534	272	530	282	524	290	520	300
3	810	394	801	408	795	423	786	435	780	450
4	1079	525	1068	544	1060	564	1048	581	1040	600
5	1348	657	1336	681	1324	704	1312	727	1299	750
6	1618	788	1603	817	1589	845	1574	872	1559	900
7	1888	919	1870	953	1855	986	1836	1017	1819	1050
8	2157	1050	2138	1089	2120	1127	2098	1162	2079	1200
9	2427	1182	2405	1225	2384	1267	2361	1308	2339	1350
10	2696	315	2673	1362	2649	1408	2624	1454	2598	1500
1	9	4	9	5	9	5	9	5	9	5
2	18	8	18	10	18	10	18	10	18	10

	31 d.	59 d.	32 d.	58 d.	33 d.	57 d.	34 d.	56 d.	35 d.	55 d.
1	257	154	254	159	252	163	249	168	246	172
2	514	309	508	318	504	326	498	336	492	344
3	772	463	763	477	755	489	747	504	738	516
4	1028	617	1017	636	1007	653	995	671	983	688
5	1285	772	1272	795	1258	817	1243	838	1228	860
6	1542	927	1526	954	1510	980	1492	1006	1474	1032
7	1809	1081	1780	1113	1762	1143	1741	1174	1720	1204
8	2057	1235	2034	1272	2013	1307	1990	1142	1966	1377
9	2314	1390	2288	1431	2265	1470	2238	1510	2212	1549
10	2571	1545	2544	1590	2516	1634	2487	1677	2457	1721
1	9	5	8	5	8	5	8	6	8	6
2	18	10	16	10	16	10	16	12	16	12

	36 d.	54 d.	37 d.	53 d.	38 d.	52 d.	39 d.	51 d.	40 d.	50 d.
1	243	176	240	180	236	185	233	189	230	193
2	486	352	480	360	472	370	466	378	460	386
3	729	528	720	541	709	555	699	567	690	578
4	971	705	960	721	945	739	932	756	920	771
5	1213	881	1198	902	1182	923	1165	944	1149	964
6	1456	1057	1439	1082	1418	1108	1398	1133	1379	1157
7	1699	1234	1678	1262	1654	1293	1631	1322	1609	1350
8	1942	1410	1918	1443	1890	1479	1865	1511	1839	1543
9	2185	1586	2157	1624	2126	1663	2098	1700	2069	1735
10	2427	1763	2395	1805	2364	1847	2331	1888	2298	1928
1	8	6	8	6	8	6	8	6	8	6
2	16	12	16	12	12 6	12	16	12	16	12

	41 d.	49 d.	42 d.	48 d.	43 d.	47 d.	44 d.	46 d.	45 d.	45 d.
1	226	197	223	201	219	205	216	208	212	212
2	452	394	446	402	438	410	432	416	424	424
3	678	591	669	603	658	614	648	625	636	636
4	905	788	892	803	878	819	864	833	849	849
5	1132	984	1114	1003	1097	1079	1079	1042	1061	1061
6	1358	1181	1337	1204	1316	1295	1295	1250	1273	1273
7	1584	1378	1560	1406	1535	1511	1511	1458	1485	1485
8	1810	1575	1783	1607	1754	1727	1727	1666	1697	1697
9	2036	1772	2006	1807	1974	1943	1943	1874	1910	1910
10	2264	1968	2229	2007	2194	2158	2158	2084	2122	2122
1	8	7	7	7	7	7	7	7	7	7
2	16	14	14	14	14	14	14	14	14	14

The Structure of this Table is from this ground:

As *Radius* is in proportion to the Distance of two places measured in their Rumbe, so is the Sine of the complement of that Rumbe, to the difference in latitude of these two places.

And so is the sine of that Rumbe, to the distance of the *Meridians* of those two Places. As admit I measure South-Easterly 20 deg. 00 Poles, here then the Rumb upon which I measure, making with the Meridian an angle of 20 degrees, I say,

As *Radius* is in proportion	
to the distance measured 300 poles	2.47712
So is the sine complement the Rumb, S E 20 deg.	9.03299
to the Difference of latitude 281 $\frac{21}{100}$ *fere.*	2.45011

Whereby it appears, that the distance of the Parallels of these two places is 281 $\frac{21}{100}$ Poles; or that the place whereto I measure, is more Southerly then the place from which I measured, by 281 $\frac{21}{100}$ poles. Now for the distance of their Meridians, say,

As *Radius* is in proportion	
to the distance measured 300 poles;	2.47712
So is the sine of the Rumb S E 20 deg.	9.53405
to their distance in longitude 102 $\frac{606}{1000}$	2.01117

Ch	*Poles*
1	28.19
2	56.38
3	84.57
4	112.76
5	140.95
6	169.14
7	197.33
8	225.52
9	253.71
10	281.92

And thus I finde the place whereto I measured is more *Easterly* then the place from which I measured by 102 $\frac{6}{10}$ poles, and somewhat more. And in like sort may be found all the other numbers expressed in this Table; but having thus found for every Degree to 45 Degrees two numbers, the rest may be deduced from them, as in this Example: 300 poles at three poles to the Chain, is an hundred Chains or ten Changes, finding that in ten Changes upon this Degree, the difference Southerly is 281 $\frac{2}{10}$ poles, it must be for five Changes, which is just halfe so much by

by almoſt 141, and for one Change, which is a tenth part $28\frac{4}{11}$ *fere*, and ſo for two Changes twice ſo much, that is, $56\frac{1}{10}$ for three Changes thrice ſo much, that is, the ſumme of the two former, namely, $84\frac{6}{10}$, and ſo by Addition onely you may finde the reſt, as in this Table, which I ſhall need to proſecute no further. And thus you may make it to the hundreth or thouſand parts of a Pole, but this for ordinary occaſions, for which it was at firſt intended, may ſuffice.

And according to this Example, it will be eaſie to frame the like Table for a Chain of any other ſize, or for any other meaſure which you uſe.

It may be objected, that howſoever this Rule holds true in Plain Triangles, yet the Triangles here uſed are neither plain nor Spherical; for a plain Triangle is made of three right Lines, and a Spherical of three Arches of great Circles; but in this the three ſides are of three ſeveral kindes; namely, one ſide is an arch of the Meridian, and ſo of a great Circle, another an arch of a Parallel, and ſo of a leſſer Circle, the third ſide or *Hypothenuſal* being the Rumb, is no arch of a Circle, but a ſegment of an Heliſpherical line.

But I anſwer, that notwithſtanding this may be ſpeculatively conceived, and ſo demonſtrated to be no plain Triangle, yet in ſo ſmall Diſtances as theſe which here we uſe, there can be no ſenſible nor ſcarce any numerable difference. Yea, the diſtance between two parallels by the Rumb and Diſtance given (being the thing here chiefly aimed at) is very exactly found by this Rule, as before we have ſhewed, and as is more fully demonſtrated by *Mr. Wright*, in the 12 Chapter of his Book, *Of the correction of Errours in Navigation*: Whence we may conclude, that the parts of the *Meridian* collected by this Table according to the Rumbs and Diſtances, as we have before ſhewed, do give the true meaſure of the ſegment of that *Meridian* intercepted, between the parallels of the two places propoſed.

CHAP IV.

Of the difference of Longitude, Position and Distance of York *and* London : *And how the Maps of* England *may by this Experiment be reformed, especially in the Latitude of Places.*

WE come next to speak of the Easterly and Westerly distances gathered as before is shewed by these Tables, and to finde thereby the difference of Longitude, and of this we will give an Example in the fore-said Experiment: whereby we finde that the distance in Longitude : or the East and West distance between *York* and *London* is neer 14000 Poles, *London* being so much more Easterly then *York*. And before we have found that in a degree of the *Meridian*, and consequently in a degree of the Equinoctial there is neer $3700\frac{1}{10}$ Chains, at six Poles to the Chain, and this 14000 Poles converted into such Chains is $2333\frac{1}{3}$.

Which $2333\frac{1}{3}$ Chains (for finding the difference of Longitude) are not to be reckoned in the Parallel of *York*, that being too much Northerly, neither in the Parallel of *London*, being too much Southerly, but in a middle parallel between both, namely, about the Latitude of 52 degrees 45 minutes. Now to finde what difference of Longitude is answerable to this $2333\frac{1}{3}$ Chains in the parallel of 52 degrees 45 minutes, say,

As *Radius* is in proportion

to Sine complement the Latitude *sc* 52 deg. 45 min.	9.78197
So is the measure of a deg. in the Equinoctial $3709\frac{1}{10}$	3.56927
to the measure of a degree in that Parallel $2245\frac{1}{10}$	3.35124

And

And thus we finde that in the Parallel, whose Latitude is 52 degrees 45 minutes, there are 2245$\frac{1}{10}$ Chains answering to a Degree, whereby it appears that the difference of Longitude between *York* and *London* is more then one degree, and to finde how much more, say again by the Rule of Proportion:

As the measure of a degree 2245$\frac{1}{10}$ *Co. ar.*	6.64876
Is to a degree in *Seconds*, 3600	3.55630
So is the measure given, 2333$\frac{3}{4}$	3.36797
to the number of *Seconds*, 3741	3.57303

Which reduced, is 1 deg. 2 min. 21 seconds, and thus we finde that *London* doth differ in Longitude from *York* 1 deg. 2 min. 21 Seconds, being so much more Easterly.

Thus having the difference of Latitude, as also the difference of Longitude between these two places, we may (according to the second Problem of Sailing by *Mercators Chart*) finde the Rumb from *London* to *York* to be 14 degrees 20 minutes from the North to the Westwards; that is, North by West 3 degrees 5 minutes Westerly, and the distance in that Rumb 9442 Chains. But their distance in the High-way, by reason of the crookednesse and unevennesse of it, was more by about an eighth part.

And the like might be done for other intermediate Places between these, but effecting brevity we passe that over, as not much pertinent to our present purpose, only expressing the Latitudes of some of the principal of them, as followeth.

	Latitudes.
As the Latitude of *York*, we finde to be	53 deg. 58 min.
Doncaster	53 deg. 32 min.
Newark upon *Trent*	53 deg. 5 min.
Grantham	52 deg. 54 min.
Stamford	52 deg. 38 min.
Huntington	52 deg. 19 min.
Royston	52 deg. 3 min.
Ware	51 deg. 48 min.
London	51 deg. 30 min.

We

We further noted in this Experiment, that howſoever the number of miles between *Ware* and *London* are almoſt the ſame by eſtimation that they are by meaſure; yet all the way beſides from *York* to *Ware*, a meaſured mile conſiſting of 320 Poles is but three quarters of a mile, as the miles lie by eſtimation or common account; ſo that every where (for the moſt parr) three miles by eſtimation make four meaſured miles. And a minute or the ſixtieth part of a Degree, is almoſt in the middle between them both: So that look how much a meaſured mile is leſſe then a minute, ſo much or ſomewhat more is a mile by eſtimation greater then a minute; for as there is contained in a Degree of meaſured miles $69\frac{1}{2}$ and ſomewhat more, as we have before ſhewed, ſo of our common eſtimated miles, there are contained about $51\frac{2}{7}$ in a Degree.

Upon theſe grounds the whole *Map* of this Kingdom might be much rectified, eſpecially in the Latitude of Places; for though we cannot hence determine certainly the Latitudes of any other places beſides thoſe which were in the way, or at leaſt in ſight as we came up (the principal of which we have before noted.) Yet we may neeerly conjecture the Latitudes of moſt parts of *England*, by their Diſtances and Poſitions from theſe; but theſe things being beſides our ſcope and purpoſe in this place, we ſhall onely compare the latitude of ſome principal places, probably gathered from this Experiment, with the Latitudes of the ſame places, as they are ſet down by *Mr. Speed* in his *Geographical* Deſcriptions of *England*; that ſuch as pleaſe to examine both in any particulars, may know to which they may more ſafely lean.

Canon-

	Latit. by this Exper.	Latit. by *M. Sp.* map		Latit. by this Exp.	Latit. by *M. Sp.* map
	D. *M.*	D. *M.*		D. *M.*	D. *M.*
Canterbury	51 17	51 29	*Norhampton*	52 14	52 36
Chicheſter	50 48	50 51	*Huntington*	52 19	52 44
Guilford	51 12	51 22	*Stamford*	52 38	53 04
Wincheſter	51 03	51 11	*Leiceſter*	52 40	53 06
Dorcheſter	50 40	50 44	*Lincoln*	53 14	53 50
Exceſter	50 43	50 48	*Newark* upon *Trent.*	53 05	53 38
Wells	51 12	51 22	*Nottingham*	53 00	53 32
Salisbury	51 04	51 12	*Darby*	52 58	53 30
Reading	51 28	51 42	*Stafford*	52 52	53 22
London	51 30	51 45	*Shrewsbury*	52 47	53 16
Colcheſter	51 58	52 16	*Cheſter*	53 16	53 52
Ipſwich	52 08	52 30	*Lancaſter*	54 10	54 57
Norwich	52 42	53 10	*York*	53 58	54 44
Cambridge	52 12	52 32	*Richmond* in *Yorkſhire.*	54 28	55 18
Hertford	51 49	52 06	*Kingſtone* upon *Hull.*	53 48	54 29
Bedford	52 08	52 30	*Doncaſter*	53 32	54 12
Buckingham.	52 00	52 20	*Durham*	54 50	55 45
Royſton	52 04	52 24	*Carlile*	55 00	55 56
Oxford	51 46	55 02	*Newcaſtle*	55 03	56 01
Gloceſter	51 53	52 12	*Barwick.*	55 54	57 03
Hereford	52 07	52 27			
Worceſter	12 14	52 06			
Warwick.	52 20	52 45			

The Latitudes of theſe Places in the firſt Column expreſſed, are ſuch as are probably gathered from this Experiment, But in

in the ſecond Column, there is ſet down the Latitudes of ſome places, as they are expreſſed by *Mr Iohn Speed* in his *Map* of *England*, ſet forth in his Book, entituled *The Theatre of the Empire of great Brittain*, and leaſt there ſhould be any miſtake in his *Map*, I have conferred theſe Latitudes thence gathered with the Latitudes of the ſame Places ſet down by him in words at large, in his deſcriptions in each ſeveral County, and finde them neerly to agree, except in the Latitude of *Barwick*, which in his *Map* he makes to be 57 degrees 3 minutes, but in his Hiſtorical Deſcriptions of *Northumberland*, he relates it to be 55 degrees 48 minutes, which laſt is much neerer the truth, but ſeems not to be his meaning; becauſe then he ſhould make it more Southerly then *Newcaſtle*, yea more Southerly then he doth *Carlile*, which by his *Map*, and alſo by his words in his Relation of *Cumberland* is in the Latitude of 55 degrees 56 minutes. Whereas *Barwick* is above 50 miles more Northerly.

By theſe you may neerly conjecture the Latitudes of other parts of *England*, lying in or neer the ſame Parallel with any of them: And hence alſo it appears, that the difference of Latitude between *Barwick* and the South-coaſt of *England* neer *Chriſt-Church*, is little more then 5 degrees, not 6 degrees and more, as ſome of our *Maps* make it. But theſe things we muſt leave, that we may proceed to that which is principally intended, onely we will firſt touch a little upon the uſe of the fore-going Table in Plotting and Surveying of Land.

CHAP.

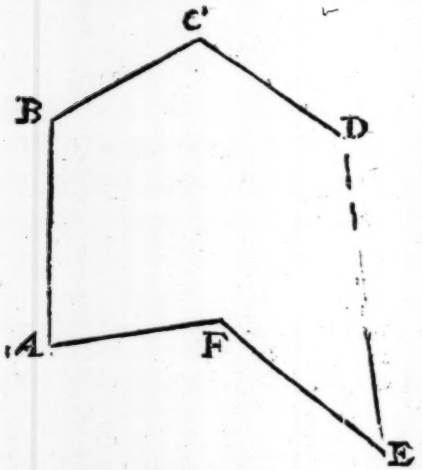
CHAP. V.

To Delineate the Plot of any Forreſt, Park, Common, or other piece of Ground: as alſo of Rivers, Harbours, &c. ſpeedily and moſt exactly.

MY intent is not here to proſecute at large the Plotting of Grounds, being a thing handled by others, treating of Surveying: But conſidering that the wayes by them directed and by others practiſed, in delineating or laying down the Diſtances and Angles obſerved by the *Circumferentor*, *Theodolite*, *Peractor*, or other graduated Inſtrument is by a *Protractor*, and that the Table before going, or that which followeth towards the end of this Treatiſe, ſerveth for that and the like purpoſes, almoſt as ſpeedily, and farre more exactly, I ſhall crave leave to digreſſe a little to ſhew this uſe of it as briefly as I may. Therefore paſſing over the method to be uſed in ſetting down the Names of the Grounds, the Tenants, Borderers, and other remarkable things, and leaving every man in theſe to the wayes whereunto he is accuſtomed. You may (as ſometimes I do) make a Book in a long *Octavo*, and upon the left ſide thereof ſet down ſuch things, as theſe before mentioned, reſerving every right ſide, and dividing them by Ruled Lines into ſix Columnes; as hereafter following appeareth.

And having taken and ſet down your Notes in the Field on the left ſides or pages of your Book, you may in the Evening or next morning before you go out, or when elſe your occaſions will permit, ſet down in the firſt Columns on the right ſide, how many Degrees the Lines upon which you have traveſled, are diſtant from the North or South part of the Meridian towards the Eaſt or Weſt, and in the ſecond Columns the quantity of the ſame Lines, in Changes, Chaines, and ſingle Poles, and parts of Poles.

As in this Figure, ſuppoſe the Line from A to B to be directly Eaſt ſeven Changes, that is, ſeven times 30 Poles, or 210 poles, from B to C to the Eaſtwards of the South 35 degrees, 5 Changes, and one Chain, from C to D, to the Weſtwards of the South 32 degrees, five Changes, and four Chains, from D to E,



to the Weſtwards of the South 80 degres, ten Changes, from E to F, to the Eaſtwards of the North 35 deg. ſix Changes, three Chains, and two thirds of a Pole. And laſtly, from F to A, the place where I firſt began to the Weſtwards of the North 9 deg. 5 Changes, 3 Chains, $2\frac{1}{2}$ poles: All theſe I expreſſe in the firſt and ſecond columns on the right ſide, as hereafter following appeareth.

Which done, I take the Table, and finde there the Northing and Southing, Eaſting or Weſting anſwerable to theſe Degrees and Diſtances, and ſet them down accordingly. As for the firſt being Eaſt ſeven Changes, I ſet down in the Eaſt columne 210 Poles

Poles with a Cipher behind it. For the ſecond being *S E*, 35 deg. I finde in the Table for 5 Chaines 1228, to be ſet in the South Column, and 860 for the East Column: alſo upon the ſame degree for 1 Chain 25 for the South Column, and 17 for the East Column; And ſo proceed with all the reſt, untill I have finiſhed.

Deg.	*Diſt.*	*North*	*South.*	*East.*	*Weſt.*
East.	0			2100	
S E 35	1		1228	0860	
			0025	0017	
S W 32	4		1272		0795
	0		0102		0064
S W 80	0		0521		2954
N E 35	3	1474		1032	
	2/3	0074		0052	
		0005		0004	
					0234
N W 09	3	1481			0014
	1/2	0089			0004
		0025			
		3148	3148	4065	4065

And being thus returned to my firſt Station, I ſumme up ſeverally theſe four Columns of North, South, East and Weſt; and finding that the ſumme of the North column is equal to that of the South, and the ſumme of the East is equal to that of the Weſt. I conclude the whole Work to be truly performed, whereas if there had been any difference, it had ſhewed an Errour, and if that difference had been great, it had been neceſſary to examine the Work again, and ſo to correct it.

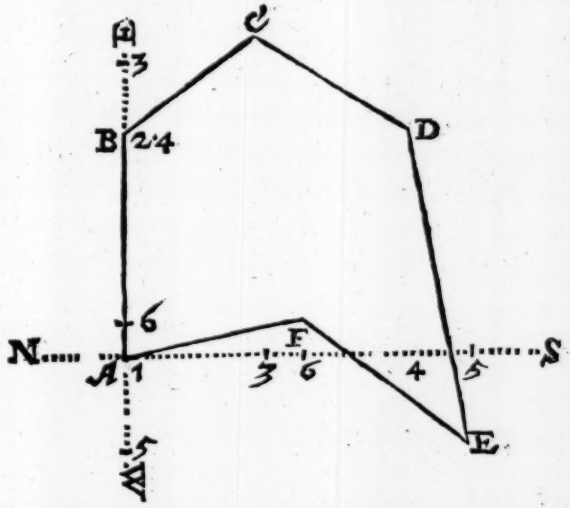
It is usual to adde together all the angles, and also to multiply two right angles, or 180 degrees by the number or angles lacking two, and if the summe of the angles added together be equal to this Product, the Work is thought to be true: as here, if we adde the inclinations and reclinations of these Lines in this Figure, the sum is 720 deg. or eight right angles, and if we multiply two right angles by 4, (because here are six angles) the Product is also eight right angles. But the other by the summes of the Columnes, is a most absolute way for examining the truth of your work, and to be preferred before any other that I know.

It may seem very laborious to set down every Station in this manner, but one that is a little exercised in it may, as I take it (for I never observed the time exactly) set down 40 or 50 Stations in this manner, within the space of an hour, or thereabouts; but I should advise that it be done by two men, having each a Table for that purpose to avoid all mistakings.

If your Instrument give not the angle with the meridian expressly, yet it may easily be gathered thence, or else you may divide a Circle as your Instrument is divided, and number the Degrees as they are there numbred, which done, number them also from the North and South part of the meridian towards the East and West, so shall you easily know the angle of any Degree with the meridian.

Now to proceed, these measures may be set down in a Plot several wayes. As first, considering which way the Ground lies, I take a point for my first Station, so as the whole may fall conveniently within the plot, which let be the point A, by which point I draw a meridian and parallel, namely two right lines intersecting one another at right angles: whereof let *N S* be the meridian running North and South, and *E W* the parallel running East and West; this done, I look to the North and South Columns, and there first in the South Column, and against the third Station, I finde 1253, that is, $125\frac{3}{10}$ Poles, this I set in the meridian from A, to the Southwards, and mark the point with the figure 3, then in the South Column against the fourth Station,

Station, I finde 1374, which I ſet in the Meridian from 3 to 4: alſo againſt the firſt Station I finde 521, which I ſet in the Meridian from 4 to 5. Then againſt the Sixth Station, I finde in the North columne 1553, which I ſet in the meridian from 5 to 6: alſo againſt the ſeventh Station, which is the ſame with the firſt, I finde 1595, which I ſet in the meridian from 6, and it falls upon A, which is the firſt Station: and thus I have done with the South and North columns.



In like ſort I expreſſe the meaſures in the Eaſt and Weſt Columns in the Parallel E W. As finding firſt in the Eaſt Column 2100, I ſet it down from A to the Eaſtwards, and it extends to B, where I ſet 2, ſignifying my ſecond Station; I finde next in the Eaſt Column 877, which I ſet in that Parallel from 2 to 3, next in the Weſt Column 859, which I ſet in that Parallel from 3 to 4: and ſo I proceed with the reſt. And having thus ſet down the meaſures in the meridian and parallel, we have alſo as it falls out in this Example two Stations expreſt, namely A and B

now

now for the third; I take in the Parallel with my Compaſſes the diſtance A 3, and ſetting one foot in the meridian at 3, I ſtrike an arch neer C; alſo taking in the meridian the diſtance A 3, and fixing one foot in the parallel at 3, I croſſe the aforeſaid arch neer C, the interſection of theſe two arches is the point C, repreſenting the third Station.

In like ſort, I proceed to finde the points D E F for the fourth fifth, and ſixth Stations, then drawing Lines, namely from the firſt Station A to the ſecond B, and from the ſecond to the third C, &c. We ſhall deſcribe the Figure required A B C D E F.

Otherwiſe, whereas here you adde and ſubſtract the ſeveral diſtances of South and North, as alſo of Eaſt and Weſt by your Compaſſes; you may with a little more pains adde and ſubſtract them by the Pen, which is the better way.

As having ſet down in the meridian the Southerly diſtance of the third Station 1253, I adde thereto 1374, which is againſt the fourth Station, the ſumme is 2627; the Southerly diſtance of the fourth Station, which I ſet in the meridian from A to 4. Again, to this I adde 521, ſo have 13148, the Southerly diſtance of the fifth Station A 5, from which ſubſtracting 1553, the Northerly diſtance ſet againſt the ſixth Station, there remains 1595, which is the Southerly diſtanee of the ſixth Station, to be ſet in the meridian from A to ſix. Laſtly, from this, abating the Northerly diſtance of the firſt Station from the ſixth, which I finde there alſo to be 1595, there remains 0. Shewing that I am returned to the ſame Parallel, or Eaſt and Weſt line, in which at firſt I began. And in like ſort, you may proceed with the Eaſt and Weſt columns, and then by the interſection of two arches, finde every Station, as before.

Other wayes might be preſcribed, which will not be hard to finde of your ſelf. And as we may thus lay down any irregular right-lined Figure far more exactly then by the *Protractor*: So when it is laid down after this manner, we may caſt up the *Area* or Superficial quantity of it very exquiſitely; Yea, if there ſhould be a Plot drawn (according to the Angles and Diſtances here given) after the uſual manner by a Scale

Scale ſo large, that the Plot ſhould be an hundred times ſo great as this; Yet could not the content thereof be caſt up ſo exactly and certainly as it may be here.

But I muſt not inſiſt upon theſe things, they may of themſelves be conceived, and mine intent is onely to touch them, that I be not prevented of time, and by other occaſions from handling thoſe things which I have here more ſpecialy intended.

But as I have ſaid, this courſe is chiefly to be uſed in plotting large grounds, and there indeed are graduated Inſtruments, eſpecially to be uſed: for other ſmaller grounds, there is none more fit then the *Plain Table*.

CHAP. VI.

Of the Compaſſe of the Earth, and the quantity of a Degree, according to the moſt approved Experiments Ancient and Modern.

ALthough the Compaſſe of the Earth hath been in ſome ſort obſerved by divers of the Ancients: Yet for ſome of them we cannot certainly gather what meaſures they uſed; others uſed no meaſure at all, but aſſumed the Diſtance of Places to be ſuch as it was eſtimated by Travailers to be, and likewiſe the Latitude; therefore it will be needleſſe to inſiſt upon the examination of their Obſervations, others of them which were taken by meaſure, and which we may upon any good Ground reduce to our meaſures, are theſe which follow.

Willebrordus Sneilius in his Book entituled *Eratoſthenes Batavus*, cites *Abel Fedas*, a moſt diligent Arabian-Geographer, that lived about the year of Chriſt 1322, who records, that about

about the year of Christ 827, certain men skilful in the *Mathematicks*, did by the commandement of their Prince *Almanon*, measure in the fields of *Mesopotamia* (as he gathers) under one and the same meridian, from the North towards the South, the quantity of a degree, and found it to be 56 miles or somewhat more. The quantiy of their mile, according to *Alphraganus*, was 4000 Cubits, or 6000 Feet, whence the quantity of a degree should be 336000 Feet, but of the length of their Feet we are something uncertain, onely they define it to be so long as the extent of 76 barley corns laid side by side; whereas the *Rhinland*-foot, according to trial by him made, is but the extent of 90 cornes laid in like manner, so that if there be no inequality in the grains, then 90 *Arabian* feet are equal to 76 *Rhinland* feet. But 96 *Rhinland* feet are found to be about 91 $\frac{1}{2}$ *English*-feet, therefore also, by the Rule of Proportion, 336000 *Arabian* feet do make of our *English* feet 370222. So that according to this experiment of the *Arabians*, a Degree should contain 370222 of our *English*-feet. And before we have found by the Observations taken at *London* and *Yorke*, and by the distance of their parallels measured, that a Degree contains of our *English* feet 367200. The difference is onely 3022 feet, that is about the $\frac{1}{118}$ part of a Degree or half a minute.

He cites next *Alhazen* the *Arabian*, who in his Book *de Crepusculis*, declares the compasse of the Earth to be 24000000 Paces, so that proportionally there must be in one degree 66666 $\frac{2}{3}$ paces, that is 333333 Arabian feet. And seeing that 90 Arabian feet make of our English feet 99 $\frac{1}{2}$, therefore by the Rule of Proportion 333333 Arabian feet, make of our English feet 367283: So that according to *Alhazen*, there should be in a Degree 367283 of our English feet differing from the Experiment which I made onely 83 feet in a Degree.

I have not strained these numbers to bring them to this neerenesse, they are the same in effect which are set down by *Snellius* in his *Eratosthenes Batavus*, who with great industry and judgment hath compared the measures of the Ancients, and the measures used by several Nations in these times, with the *Rhin-*

Rhynland-foot. Much leſſe have I ſtrained mine own numbers to draw them up to theſe: But on the contrary, I confeſſe upon the ſight of his Book, obſerving the great pains and induſtry which he confeſſeth himſelf to have beſtowed, and which I doubt not but he did imploy in making his Experiment, and how he had found the meaſure of a degree to be much leſſe then mine, as we ſhall after ſhew, I began to doubt that I had not made ſufficient allowance for the unevenneſſe of the wayes, and for ſome ſmall bendings, ſometimes to the right hand, ſometimes to the left, the obſervation whereof I wittingly neglected, to ſpare time and expence. For I did often obſerve a mile or two before me, ſome mark in the High-way noting the degree, and meaſuring to it in the way, neglecting to obſerve the intermediate ſwervings of the way, ſometimes three or four degrees towards the right hand, ſometimes aſmuch to the left, but making ſuch allowance for thar, and for the unevenneſſe as I judged ſufficient. And ſome men may think, that the exact Obſervation of theſe leſſer things thus neglected and regulated onely by judgment or conjecture might deceive me much: But they may conſider, that if there be two places a mile diſtant, that is, in a right line 320 Poles, if you meaſure from one of theſe places towards the other, not in that right line, but alwayes ſwerving from it by an angle of 4 degrees, ſometimes to the right hand, ſometimes to the left, till you come to that other place; I ſay, that notwithſtanding all theſe ſwervings (if there be nothing elſe to augment the meaſure) it will not amount to 321. Now conſidering that I had all the way, as occaſion required, made ſuch allowance as ſeemed convenient, and ſo found 367200 Feet in a degree, before I compared it with the meaſures taken by any other: I reſolved not to diminiſh nor to augment the number thus ariſing by my Obſervations, Meaſures, and Allowances, in reſpect of the Opinions, Obſervations, or Meaſures of any other man, until there be made ſome Experiment more evident and exact then any yet extant. And I am ſomething the more confident by the neer agreement of theſe two teſtimonies before recited, both exceeding me a little in the meaſure of a degree. But we cannot con-

fidently rest upon them, because of that inequality which may be of Corns or Grains; for theirs may haply be something greater or lesser than ours.

Both these measures of a Degree do much exceed the quantity of a Degree found by *Snellius*, but when he compares them with his own another way, namely, placing the Barley-corns so that they may not lie flat, but be set up edge-wise, and so by 96 Corns to make a Foot, and by such feet to measure a Degree; then he findes that the quantity of a Degree, according to the *Arabians*, is much lesse than by his Experiment it should be: but if some be laid flat, and others set up edge-wise, the *Arabian* measure of a degree will agree with his. And so he proposeth this doubt, whether the 96 grains whereof the *Arabian* foot doth consist, must lie flat or be set up edge-wise, or some of them to lie flat, and others to be set up edge-wise. But it is most probable that they must lie flat, that being the position which they are apt unto by nature; they cannot be set edge-wise without much trouble, especially so many together as make the length of a foot, and so the *Arabian* measure of a degree doth neerly agree to this of mine.

We come next to hear the determination of *Ptolomy* of *Alexandria*, whose authority and credit in the solution of this question is not inferiour to any of the Ancients. He affirms the compasse of the earth to be 180000 *Stadiums*, and the quantity of a degree 500 *Stadiums*; the same (as *Strabo* saith in his 2 Book of *Geographi*) was before affirmed by *Posidonius*. Also *Marinus Tyrius* (before *Ptolomy*) had determined the quantity of a Degree to be 500 *Stadiums*. *Ptolomy* confirms it, not simply from their relations, but as it seems from his own experience, and that by some measures diligently taken, for in the 11 Chapter of the first Book of his Geography, he hath these words; *Sed in hoc quoque recte sentit, partem unam qualium est circulus maximus tricentorum sexaginta; quingenta in terra constituere Stadia, id enim confessis dimensionibus consonum existit.* Also *lib.7. cap.5. Itaut pars una, seu gradus unus quingenta contineat Stadia, quemadmodum ex diligentibus deprehensum*

ſunt eſt dimenſionibus. Now a Stadium not onely amongſt the *Greeks*, but as appears by *Herodotus* amongſt all other Nations of *Aſia* and in *Egypt*, did conſiſt of 600 feet; therefore a Degree according to *Ptolomy*, muſt contain 300000 feet. But the *Egyptian* or *Alexandrian-foot* was much greater then our foot; for as we have before ſaid, the ancient *Roman-foot* is greater then ours, and the *Egyptian-foot* was much greater then the *Roman*: For it is often teſtified by *Hero Mechanicus*, that five *Alexandrian* feet make ſix *Roman* feet. And Mr. *Snellius* hath very ingeniouſly gathered both from *Philandes* and otherwiſe, that the *Rhynland*-foot is equal to the ancient *Roman*-foot; therefore alſo five *Alexandrian*-feet are equal to ſix *Rhynland*-feet: So that by the rule of proportion, 300000 *Alexandrian* feet will make of *Rhynland* feet 360000. But by the ſize of our *Engliſh* foot, which was ſent him from the Iron Standard in *Guild-hall*, he finds it to contain but 968 ſuch parts as the *Rhynland* contains 1000: So that 968 *Rhynland* feet are equal to 1000 *Engliſh*, or 121 *Rhynland* feet are equal to 125 *Engliſh* feet. Therefore alſo by the Rule of proportion, 360000 *Rhynland* feet are equal to 371900 of our *Engliſh* feet. Therefore according to *Ptolomy*, there are contained in a Degree 371900 of our *Engliſh* feet. But by our fore-mentioned Experiment made between *York* and *London*, we find onely 367200 feet in a Degree, being leſſe then *Ptolomies* by 4709 feet, that is, by $\frac{1}{77}$ part of a Degree, or $\frac{3}{4}$ of a *Minute*, and little more.

Fernelius a modern Author and learned Phyſician, meaſuring the way by the Revolutions of a Wheel, and the Latitudes by Obſervation, finds in a Degree 68 *Italian* miles, and 96 paces, the Pace which he uſed being more then five of our *Engliſh* feet: But becauſe he handled not the Probleme exactly, and as ſuſpected by *Snellius*, (though I think without cauſe) to have grounded his Concluſion rather upon the Experiment of the *Arabians* before ſet down (wherewith it doth neerly agree) then upon his own, we will inſiſt no longer upon it.

We come in the laſt place to the Experiment of *Willebrordus Snellius*, a *Hollander*, made in the *Netherlands* about 20 years

paſt. We ſhall not need to recite the particulars of it, being extant at large in his Book before-mentioned, but in Concluſion he findes in a Degree 342000 *Rhynland*-feet. Now a *Rhinland* foot (as he hath there ſhewed, comparing both together) is greater than ours, and that in ſuch Proportion, as 1000 to 968, (and ſo much or little more it appears to be by that *Model* of the *Rhinland* foot printed in his Book) therefore 968 *Rhinland* feet muſt make 1000 of ours; and hence by the Rule of Proportion, 342000 *Rhinland* feet will make of our Engliſh feet 353306. So that there ſhould be in a Degree onely 353306 feet, which is leſſe then we have before found in a Degree, by 13894 feet, that is, by $\frac{1}{17}$ part of a Degree, or $2\frac{1}{4}$ Minutes, and ſomething more. He was a man doubtleſſe of ſingular induſtry and knowledge, and of much exerciſe in the Mathematicks, and it may be, was well experienc'd in this particular, touching the Geometrical menſuration of Diſtances, and he hath beſtowed much pains and diligence in this Experiment, as by his Book appeareth. But if he had by a Chain meaſured the Diſtance of his two utmoſt Stations (if the ground would permit, which I ſuppoſe it would not) or at leaſt-wiſe if his meaſured Stations had been further diſtant: I conceive he would have found a greater Diſtance in his two utmoſt places of Obſervation. But if a man intending to finde the Diſtance of two places, meaſure onely the $\frac{1}{100}$ part of that Diſtance, and by that meaſured Line and the angles, think to finde their true Diſtance; whether he do it immediately from thoſe two meaſured Stations, or mediately by help of others obſerved from them, he may eaſily fall into ſome notable errour. For though the Problem be exactly true in Geometrical Demonſtrations, how ſmall ſoever the meaſure be, yet it is not ſo in ſenſible and experimental practiſes, by reaſon of the weakneſſe even of the beſt eye, and the imperfection of the Inſtruments in themſelves, and in their uſe. And beſides that, there were many Stations obliquely ſituate; A man cannot alwayes hit the juſt middle of that Turret, Steeple, or other mark which he obſerves: Neither when he comes to make his Station there, can he always place his Inſtrument juſt at the concourſe of his former:

mer visual Lines, by reason of other impediments. Besides the force of the winde in such eminent places: and moreover that amongst so many Steeples as there are in some Townes, there, a man may at sometime mistake one for another. And if there should happen no notable Errour, by reason of any or of all these Casualties: Yet may two minutes in the difference of the Latitude of two places be easily mistaken, especially being derived from the Latitudes of those places which are very rarely set down true to a minute.

If it be objected, that I might aswell be so much mistaken in the difference of the Latitudes of *York* and *London*.

I answer, it is not so likely, because I had the opportunity of observing the Summer Solstitial Altitude of the Sun in both places, wherein I had no necessary use of the Suns Parallax nor Refraction, nor of the Table of the Suns Declination, any of which may cause more then a minutes errour, in finding the Latitude of either place.

Besides, if mine Errour in those Observations should be full as much, yet would it not in the Conclusion be half so much, because the difference in Latitude of the two places of mine Observation is more then twice so much as that of his.

But let this suffice, leaving every man to imbrace that which he shall best approve. Both our Experiments do sufficiently convince that common errour of counting onely 300000 *English* feet to a Degree, besides the consent of other Observations before recited ancient and modern.

Mr. *Snellius* hath further in that Book of his, entituled *Eratosthenes Batavius*, with much diligence compared some ancient measures, as also the measures of sundry Forreign-Countreys with the *Rhyniand* foot; and amongst the rest our *English* foot, according to a size thereof to him sent from the *Standard* to *Guild-Hall*, (from whence also I had about twenty years past the size of that Foot which I have used in this measure) we shall not need to repeat them all, because his Book is extant: some of them are these following, which we here compared to our *English* foot, as he hath there done to the *Rhyniand*, that so any of them

them may the more easily be reduced into our Feet. Therefore dividing the *English foot* into 1000 equal parts, we shew how many of those parts are contained in other ancient & forreign feet.

Ancient feet compared with our *English-foot*.

Of such parts as the *English-foot* contains		1000
The	Ancient *Roman-foot* contains	1033
	Ancient *Greek-foot* contains	1076
	Babylonian contains	1211
	Alexandrian contains	1240
	Antiochean contains	1405
	Arabian contains	1102

Forreign feet compared with our *English*.

Of such parts as the *English-foot* contains		1000
The	*Rhynland*-foot contains	1033
	Dort-foot contains	1085
	Middleburge-foot contains	992
	Amsterdam-foot contains	934
	Antwerp-foot contains	939
	Lovain-foot contains	939
	Hafnian-foot in *Denmark*	965
	Paris-foot called the *Kings*-foot	1090
	Venice-foot	1157
	Toledo-foot	896
	Nuriberg-foot	1006
	Stratsburg-foot	920

CHAP. VII.

Of dividing the Log-line, and reckoning the Ships way.

THere be four things, upon which the Practice of Navigation is especially grounded; namely, the knowledge of the Longitude, Latitude, Course, and Distance. Touching the Longitude, though it may be found by the other three, yet hitherto there hath not been delivered any general Rule true and practicable, whereby the Longitudes

gitudes of places might be immediately and ordinarily found of themſelves. The Latitudes of places may immediately be found by Obſervation of the Sun and Stars, as we have formerly ſhewed in the Appendix to the Doctrine of Triangles: The Courſe by the Compaſſe, the Variation being duely obſerved, wherein we have many good *Mariners* very expert, this we have alſo handled in the Doctrine of Spherical Triangles. The diſtance run is found of it ſelf by the *Log-line*, whereof we are here to ſpeak.

The ground of finding the diſtance run by the *Log-line* is meerly conjectural, being founded upon this opinion, that five of our feet make a pace, and a thouſand ſuch paces make a mile, and that 60 ſuch mile make a degree; ſo that a degree ſhould contain 300000 of our feet: But it appears not onely by this Experiment, but even by all others that were diligently taken, and their meaſures to us known, that there is a greater number of our feet contained in a degree.

There be three things (as I conceive) that have cauſed this errour to be ſo commonly received and tollerated. The one, for that it doth ſomewhat counterpoize another contrary errour in the Practice of *Navigation*, namely in the uſe of the *Plain chart*, for the errour which is there committed by making every parallel equal to the Equinoctial, and ſo every degree in them greater than they ſhould be, is ſomething moderated by this errour, whereby the meaſure of a degree is eſteemed leſſe than indeed it is.

For inſtance; It is evident by the *Globe*, that the *Meridians* concurring in the Poles grow neerer and neerer together, as they grow towards the Poles: Inſomuch, as if two meridians be diſtant in the Equinoctial ten degrees, that is 600 miles, the ſame meridians in the Latitude of 35 degr. will be diſtant little more than 490 miles. Now if unto every mile we account according to the former experiment 6120 feet, then is the diſtance of thoſe two meridians in that parallel neer 3000000 feet. In like ſort in the *Plain chart* ten degrees of that parallel (as of all others) is made equal to ten degrees of the Equinoctial or *Meridian*:

ſo

ſo that the diſtance of thoſe two *Meridians* will upon the *Plain Chart* be 60 miles, but one of theſe miles contains onely 5000 feet, ſo that the diſtance is but 3000000 feet, equal to the former.

And although theſe errours in other caſes do not juſtly ballance one another as in this example, yet that of the *Plain Chart* is alwayes ſomething moderated by this other, and ſo much the more by how much they are neerer to the foreſaid Latitude. I grant that this is onely ſo, when the courſe is neer unto the Eaſt or Weſt points; but withal, I ſay that this kind of reckoning is (in a manner) then onely uſed: For he that runs any courſe neer the *Meridian* Southerly or Northerly, hath a more certain way of reckoning; namely, his Latitude, which he findes daily by Obſervation of the Sun and Starres, upon which he will depend, either neglecting or at leaſt not regarding his dead reckoning. Yea, (it may be) never caſting the *Log* ſo much as once in ſuch a Voyage, having a more ſure ground for his reckoning. But in a Courſe that is neer Eaſt and Weſt (foraſmuch as there is no way diſcovered for finding the Longitude) he is driven of neceſſity to make uſe of his dead reckoning.

We might adde moreover, that the principal Voyages of this kinde, I mean of thoſe which conſiſt of Courſes much Eaſterly and Weſterly, as to and from the *Weſt Indies*, and the Parallel of *Cape bon Eſperance* are neer unto this Latitude of 35 degrees; ſo that as ſome of them are more Southerly, others of them are more Northerly.

But to inſiſt no longer upon this, I ſuppoſe a ſecond cauſe to be, for that men commonly deſire to have their reckoning before their Ship (as they ſay) that they fall not with a place before they look for it; And this comes ſo to paſſe, whileſt the miles are accounted leſſe in meaſure, and ſo more in number then they are indeed.

And thus, though there may ſeem to be ſome commodity in theſe errours, eſpecially when they do neerly ballance one another: Yet becauſe they ſeldome do ſo, but alwayes leave men in uncertainties, and oftentimes in great perplexity and danger,

it

it is much ſafer and better to reject them both, and to imbrace thoſe wayes, which are evidently grounded upon truth, though there may be in them ſome more difficulty at the firſt. Yet I confeſſe, that he which reformes one and not another, may ſometimes erre ſo much the more thereby. And I doubt not, but many would reform them both, if they could certainly do ſo.

Therefore a third cauſe of admitting and retaining this Errour ſeems to be, for that there hath been no way delivered from evident and certain grounds, for the rectifying of it. I doubt not but many have found Errours in their reckonings ariſing from hence, that they account onely 300000 of our feet to a Degree; but not knowing certainly where to lay the fault, have imputed it ſometimes to ill ſteerage, otherwhiles to the Variation of the Needle, or to ſome miſtake in their Reckoning, or to ſome errour in their Plots, or to ſome Current, or ſuch other accident, and ſo the Errour hath reſted un-reformed. Wherefore although the practical performance of this Probleme for finding the Circumference of the Earth, or the quantity of a Degree on the ſame, have many ſingular uſes which I cannot now touch; yet that which amongſt the reſt I chiefly aimed at, was that we might have a more ſure and evident ground for dividing the *Log-line*, and for reckoning the ſhips way or diſtance run more truly upon any Rumbe or point of the Compaſſe then formerly.

And now to apply it to this purpoſe, we have noted before (*Chap.* 2.) that by the Experiment there expreſſed, we finde in a Degree on the circumference of Earth and Sea, 367200 of our Engliſh feet. Wherefore retaining ſtill the ſame diviſion of a Degree into 60 miles or 20 leagues (as hath been formerly uſed) a Mile will contain 6120 feet, or 1020 fathomes: And ſo a League contains 18360 feet, or 3060 fathomes; for dividing 367200 by 60, the quotient is 6120, &c. Thus then 60 miles being a Degree, every mile is 6120 feet.

Now ſuppoſing the time of the running out of the *Log-line*, to be meaſured by an half-minute glaſſe, if we obſerve how many feet or fathom ſhe runs in half a minute; we may thereby finde her way for an hour or four hours, or for any other time propoſed.

As admit there runnes out of the *Log-line* in half a minutes ſpace 51 Feet, or 8 ½ Fathoms, and you would know what way the ſhip makes every hour after the ſame rate;

Say by the Rule of Proportion;

If 0 ½ Minute, give 51 Feet,

What gives 60 Minutes? Or,

If 1 Minute give 102 Feet:

What gives 60 minutes?

And ſo multiplying, you ſhall finde 6120 Feet, which is one mile. Or, if you would finde her way for four hours, which is 240 minutes; Say,

As 1 minute, is in proportion to 240 minutes,

So are 102 Feet, to 24480 feet, or 4 miles.

Or if you would have it in fathomes; ſay,

As 1 minute, is in proportion to 240 minutes,

So is 17 fathomes, to 4080 fathomes, the ſhips way in four hours. The like is to be conceived, if your Glaſſe be for any other quantity of time above or under half a minute.

Some have thought that the way which the ſhip maketh, may be known to an old Sea-man by experience (as they ſay) that is, by conjecture: Which opinion makes ſome neglect the uſe of the *Log*, leſt they ſhould be accounted young Sea-men. But as he that rides often will have ſome neer gueſſe how farre the Pace he rides will carry him in an hour (becauſe he hath often obſerved it formerly) ſo he which hath often ſailed and kept an account of the ſhips way by the *Log*, will be able to give ſome neer eſtimate of her way without the *Log*. But it is incident to ſome men to have ſuch a conceit of this their eſtimate, that they think it more certain then the Rule it ſelf, from whence it is derived, eſpecially if it chance to anſwer their expectations at ſome times.

It is thought alſo that the ſhips way may be known by two marks on the ſhips ſide, but this is doubtleſſe very uncertain, both by reaſon of the ſhortneſſe of the time, and in reſpect of the dead water (as they call it) by the ſhips ſide. For the water which is neer the ſhip, is drawn along with the ſhip in her motion,

motion, and ſo much the more, by how much it is neerer.

But if any deſire to make trial of this way, it is to be conſidered, that 17 foot is $\frac{1}{360}$ part of a mile, and 10 *ſec.* of a minute is $\frac{1}{360}$ part of an hour: therefore if there be two marks on the ſhips ſide diſtant 17 feet, if the ſhip run the diſtance of theſe two marks in 10 ſeconds, ſhe runs a mile an hour, if in 5 *ſec.* two miles an hour, if ſhe run that diſtance in 2 *ſec.* ſhe runs 5 miles an hour. And ſo alwayes dividing 10 *ſec.* by the number of *ſeconds*, in which the ſhip runs that diſtance, the quotient ſhews the miles and parts of a mile run in an hour.

But if the Diſtance of thoſe two marks be 34 feet, if ſhe run it in 20 ſeconds, it is after a mile an hour, if in 10 *ſiconds*, two miles an hour, if in 5 *ſec.* four miles an hour: And ſo alwayes dividing 20 *ſec.* by the number of *ſec.* in which the ſhip runs that diſtance, the quotient ſhews how many miles the ſhip runs in an hour. As if the ſhip run that diſtance of 34 feet in 8 *ſeconds*, then dividing 20 by 8, the quotient is 2 $\frac{1}{2}$, ſhewing that ſhe runs 2 $\frac{1}{2}$ miles in an hour. Or, if you can conveniently make the diſtance of the two marks on the ſhips ſide to be 51 feet (for the further they are diſtant, the better) then if the ſhip run that diſtance in 30 *ſec.* it is a mile an hour, if in 10 *ſec.* it is 3 miles an hour, and ſo alwayes dividing 30 *ſec.* by the number of *ſeconds*, in which the ſhip is running that diſtance, the quotient ſhews after that rate how many miles the ſhip runs in an hour.

Otherwiſe you may do thus, divide 17 feet into 10 parts, and ſet as many of thoſe parts on the ſhips ſide as conveniently you may, (which according to the ſhips length will be more or fewer.) Then when the ſhip runs one of thoſe parts in a *ſecond* of time, it is a mile an hour: when two, it is two miles an hour; when 5, it is 5 miles an hour. And in general, if you divide the number of parts run by the time of running accounted in *ſecends*, the quotient ſhews what number of miles after that rate are run in an hour.

As if ſhe run 30 of thoſe parts in 5 *ſeconds*, it is 6 miles an hour; for dividing thirty by five, the quotient is ſix; ſo if ſhe runne 42 of thoſe parts in ten *ſeconds*, dividing 42

by 10, the quotient is $4\frac{2}{10}$, which sheweth the ships way at that time to be after the rate of four miles and two tenths of a mile in an hour.

But for keeping this account of time it may be done either by a Sand-glasse for that purpose, or by pronouncing certain words or numbers: As the time wherein a man tells twice 60, pronouncing every number as fast as he can conveniently and distinctly, is about a minute, so that the time wherein a man is numbring 60, is a half minute or 30 seconds, and whilest a man is numbring two (as one and twenty, two and twenty) is a second, and so whilest a man is numbring from twenty to thirty, is five seconds, from twenty to forty ten seconds, &c. but in numbring from one to twenty you may observe the same times, as in numbring from one and twenty to forty, and this will not be hard to do; for whilest a man pronounceth one and twenty, two and twenty, three and twenty, &c. there remains a certain Impression in the fantasie, whereby a man is able in the same times to pronounce one, two, three, &c. And although this rule of numbring twice 60 for a minutes space be not general unto all men, because some are swifter or slower in their pronunciation then others; yet after this Example, a man making trial may frame a Rule to himself, whereby he may come something neer the truth.

But leaving these, we come to the division of the *Log-line*, according to the half minute-glasse, which is more usual and certain. And considering that half a minute is of an hour the $\frac{1}{120}$ part, therefore the ships way running 51 feet in half a minute is a mile an hour, if she run twice so much, that is, 102 feet in half a minute, it is two miles an hour; if thrice so much, it is three miles an hour. And in general, how many times 51 feet she runnes in half a minute, so many miles is her way for an hour. Therefore leaving half a score fathom, or more from the *Log*, that so it may be out of the *Eddy* of the ships wake, before you begin to account or turn the glasse, if there you make a mark for the beginning, and so 51 feet from thence a mark of one knot, and 51 feet further a mark of two knots, and 51 feet further (that is, 153 feet from your first mark) another mark of three knots,

and

and ſo proceeding: look how many knots are veered out in half a minute, ſo many miles is the ſhips way for an hour. Now for that which is veered out more above the juſt meaſure of a knot or knots, you may allow for every five feet the tenth part of a mile almoſt. As admit ſhe runne five knots, and 25 feet in half a minute, then is her way according to $5\frac{1}{10}$ or five miles and an half in an hour, if ſix knots and ten feet, it is $6\frac{1}{10}$ miles in an hour, &c.

But according to the common opinion of 5000 feet to a mile, and 60 ſuch miles to a Degree, there ſhould be ſomething leſſe then 7 fathom, namely, 41 $\frac{2}{3}$ feet to a knot.

And although he which veeres the *Log-line* be careful to overhale it ſo ſlack, that it may not draw forwards the *Log*, yet (no doubt it doth loſe ſome way, following the ſhip a little as it is drawn by the Line, and withal by the *Eddy* of the ſhips wake, and ſometimes alſo is caſt forwards by the winde and waves, when they come after the ſhip; ſo that for theſe cauſes it is like there may ſometimes be allowed three or four fathoms more then is veered out, but this, (as a thing mutable and uncertain) being ſometimes more, ſometimes leſſe, cannot be brought to any certain Rule, but ſuch allowance may be made for it as a man in his experience and diſcretion finds fit.

If you would divide the *Log-line* ſo as it might give the ſhips way in *Centeſmes*, or the hundredth part of a Degree, and fit it to an half Minute-glaſſe. Then ſeeing the hundreth part of a Degree is 36752 feet, and the $\frac{1}{120}$ part thereof is 50 $\frac{2}{3}$ feet; If you begin at the mark at which you mean to turn the glaſſe, & meaſure from thence 30 feet, and three fift parts of a foot, you may there place one knot, and thence again meaſuring 30 feet, and 3 fifth parts of a foot, there place two knots; and ſo proceeding at the end of every 30 feet and three fifths, adding a knot, the number of knots which runne out in half a minute, is the number of *centeſmes* which the ſhip runnes in an hour. As ſuppoſe there runne out ten knots in half a minute, then the ſhips way is according to ten *Centeſmes* of a Degree in an hour, that is, the tenth part of a Degree, or ſix miles. And ſo every three foot above the

juſt

juſt meaſure of knots, is neer the tenth part of a *Centeſme*, or the 1000th. part of a Degree. As if there run out of the *Log-line* 5 knots and 12 feet, then thy ſhips way for an hour is 5 *Centeſmes*, and 4 tenth parts of a *Centeſme*: the like is to be underſtood of others.

And after the form of theſe examples you may divide the *Log-line* for any other quantity of Time, more or leſſe then half a minute, or for any other parts of a Degree propoſed.

Thus have we handled the diviſion of the *Log-line*, according to the meaſure before found of 367200 *Engliſh feet* in a Degree: But becauſe (as I have before-ſhewed) the ſhips way is commonly more then by the *Log-line* it appears to be: and every man deſires to have his reckoning ſomething before his ſhip, that he fall not with a place unexpected; for theſe and ſuch other cauſes, and for the rotundity of the number, if any man think it more ſafe and convenient in Sea-reckonings, he may abate 1 in 51, and ſo aſſign to a degree onely 360000 feet, and conſequently to a mile 6000 *Engliſh feet*.

And upon this ground, if in half a minute there run out 50 feet of the *Log-line*, it is a mile an hour; and ſo if 100 feet run out in a minute.

For, as 1 minute is in proportion to 60 minutes:

So is 100 feet, to 6000 feet.

And ſo foraſmuch as twenty five feet is $\frac{1}{240}$ part of a mile, and 15 *ſeconds* is alſo $\frac{1}{240}$ part of an hour: Therefore if there be two marks on the Ships ſide diſtant 25 feet, if the ſhip runne the diſtance of theſe two marks in 15 *ſeconds*, it is after the rate of a mile an hour; if in 5 *ſeconds*, it is three miles an hour, and ſo alwayes dividing 15 *ſeconds* by the number of *ſeconds* in which the ſhip runs that diſtance, the quotient ſhews the miles and parts of a mile runne in an hour. But if the Diſtance of theſe two marks be 50 foot, then if ſhe runne it in 30 *ſeconds*, or half a minute, it is a mile an hour; if in 10 *ſeconds*, three miles an hour; if in five *ſeconds* ſix miles an hour, (for 30 divided by 5, the quotient is 6.) And ſo alwayes dividing 30 *ſeconds* by the number of *ſeconds*, in which the ſhip runnes that Diſtance

ſtance; the quotient ſhews how many miles ſhe runs in an hour, &c.

Otherwiſe, if you make a mark on the ſhips ſide at every twenty Inches, then when the ſhip runs one of theſe parts in a ſecond of time, it is a mile an hour: when 5, it is 5 miles an hour: if ſhe run 18 of theſe parts in 3 ſeconds, it is 6 miles an hour. For dividing 18 by 3, the quotient is 6. And in general, if you divide the number of the parts run, by the number of ſeconds ſpent in running, the quotient ſhews the ſhips way in miles for an hour.

But for dividing the *Log-line* according to this ground of 6000 feet in a mile, if you intend to uſe it with a half *Minute*-glaſſe; then becauſe half a minute is $\frac{1}{120}$ part of an hour, and 50 feet is alſo the $\frac{1}{120}$ part of a mile: Therefore when the ſhips runs 50 feet in half a minute, her way is after the rate of a mile an hour; if 100 feet in half a minute, it is two miles an hour, &c.

Therefore half a ſcore fathomes or more from the *Log*, you may make a mark, and beginning from thence meaſure 50 feet, and there make the firſt knot, and 50 foot farther two knots, and 50 foot farther three knots, and ſo proceeding: Look how many knots is run out in half a minute, ſo many miles is the ſhips way for an hour. And every five feet more beſides the knots is a *tenth* part of a mile; As if there run out ſix knots and 20 feet in half a minute, the ſhips way is after the rate of $6\frac{4}{10}$ miles in an hour, &c.

And ſo if the Glaſſe were for any other time more or leſſe then half a minute, you may make the diſtance of your knots proportional: As if it were for 20 *ſeconds*, then becauſe 20 *ſeconds* is of an hour the $\frac{1}{180}$ part, I divide a mile, which is 6000 feet, by 180, and the quotient is $33\frac{1}{3}$; therefore there muſt be a knot at every 33 feet and 4 inches.

If your Glaſſe be 36 *ſeconds*, which is $\frac{1}{100}$ part of an hour, divide 6000 by 100, the quotient is 60, ſhewing that there muſt be 60 feet to every knot, and then every ſix foot over and above the knots, is a *tenth* part of a mile more.

And

And ſo it is better that your Glaſſe be more than half a minute rather then leſſe, and the more the better, provided that there run out no more Line then you may hale in again, without danger of breaking.

Laſtly, if you would ſo divide the *Log-line*, that it might ſhew the ſhips way in *Centeſmes* of a Degree, and fit it to an half minute glaſſe: Then forasmuch as the hundredth part of a Degree is 3600 feet, and the $\frac{1}{120}$ part thereof is 30 feet, therefore beginning at the mark whereat you intend to turn the Glaſſe, meaſure from thence 30 feet i and there make one knot, and at thirty feet further two knots, &c. Then look how many knots run out in half a minute, ſo many *Centeſmes* of a Degree is the ſhips way for an hour. And ſo if the glaſſe be 36 *ſeconds*, then every knot muſt have 36 feet, &c.

Now if a man ſailing between any two Places, which lie neer Eaſt and Weſt one from another, have kept his reckoning by Courſe and Diſtance, uſing a *Log-line* ſo divided, that it have a knot at every 7 Fathomes (as many do) and would reduce the Diſtance of thoſe two places ſo found, to their Diſtance in ſuch miles, as theſe of ſixty to a Degree, each containing (as we have ſaid) 6000 Feet: The proportion in number of thoſe to theſe, is as 6 to 5: for 6 of them make 5 of theſe.

As admit a man in his dead Reckoning, uſing ſuch a *Log-line* as hath a knot at every 7 Fathomes, and for every knot running out in half a minute, he accounts the ſhips way to be ſo many miles an hour; and according to ſuch a reckoning ſuppoſe he finde the diſtance of two places to be 1224 Miles, or 408 leagues, and would know the Diſtance of the ſame places in miles of 6000 feet to a mile, which is according to a *Log-line* that hath a knot in every 50 feet.

Say then by the Rule of Proportion;

As the number 6	*Co. ar.*	9.22185
Is in propottion to 5,		0.69897
So is the number of miles given 1224		3.08778
To the number of miles required, 1020		3.00860

Which

Which 1020 is the diſtance of thoſe two Places, in ſuch miles whereof 60 make a Degree; Or to finde the ſame in leagues, the proportion is; As 6 to 5; ſo is 408 leagues, to 340 leagues.

And thus may the Diſtances of places be found in ſuch miles, whereof 60 make a Degree, eſpecially if with the diſtance expreſſed in the *Plain Chart*, you compare the reckoning of ſome skilful *Mariners* that have ſailed from the one to the other. But thus to endeavour a reformation of the *Plain Chart* were a labour to little purpoſe; For there the correcting of the true ſituation of two places, in reſpect of one another, is oftentimes an occaſion that the ſame places are the more falſly ſituate in reſpect of others. Like as if there were two places eight miles diſtant, and it were required to place a third three miles from either of them; Here if we ſet the third in the middle, it will be four miles diſtance from either: but if (attempting to mend that errour) we make the third to be 3 miles from the firſt, then will it be 5 miles from the ſecond: And thus unavoidably, the mending of the one is the marring of the other; becauſe the thing propoſed is not poſſible.

And ſuch is the errour of the Plain or Common *Sea-Chart*, repreſenting the Earth and Sea, not as a Spherical, but as a Plain Superficies; not as if the *Meridians* did concur in the Poles, but as if they were alwaies parallel one to another. So that the graduation and projection being ſuch, the Situations and Diſtances of places, cannot be generally and truly expreſſed therein.

But the graduation and projection of *Mercators Chart*, agreeing without ſenſible errour with the *Globe*, there may in that be deſcribed all or any parts of the World, according to their Longitudes, Latitudes, Courſes, and Diſtances, as truly and far more conveniently for the *Mariners* uſe then upon the Globe it ſelf; and upon ſuch a *Chart* ſo deſcribed, a reckoning may be truly kept, and any errour committed, may eaſily be diſcerned and amended. Whereas on the *Plain Chart*, if a man finde his reckoning to diſagree, he is ſo far from knowing how to amend it, that he can ſeldome conjecture where the fault was.

The neglect and want of theſe *Charts* hath been and is a great

imperfection in *Navigation* and *Geography*. For howſoever there be ſome which do daily ſet forth for ſale Maps of the World and of the parts thereof, according to this Projection: Yet to have them truly ſuch, and fit for Navigation, requires in the Author or maker of them good knowledge, and ſome competent ability of his own, or aid from others, with a greater love to the Truth then to his own profit, which may induce him to beſtow ſuch induſtry, time, and expence, as I have formerly noted to be requiſite in ſuch a Work.

For the furtherance whereof, and of the practice of Navigation in general; I ſhall indeavour in the two next Chapters to ſhew a methodical and orderly way of keeping a reckoning at Sea, more diſtinctly and exactly then hath been formerly uſed, and ſuch as may aptly be ſet down in any Chart, and applied in the three principal kindes of Sailing; namely, according to the *Plain Chart*, or *Mercators*, or according to the Arch of a *Great Circle*. And by a few reckonings truly ſet down, according to this form, the Maps of the World and of the parts thereof might be much reformed.

CHAP. VIII.

A formal and exact way of ſetting down and perfecting a Sea-reckoning.

ALthough the Courſe and Diſtance cannot be ſo truly and certainly known as the Latitude may be: yet we muſt indeavour in theſe alſo to come as near the Truth as may be, the rather for that ſome reckonings muſt neceſſarily depend wholly upon them. And to that end, thoſe which in their Voyages at Sea have occaſion to runne farre upon any Courſe or Courſes near the *Meridian*, may do well to make tryal of that which I have formerly ſet down, touching the quantity of a Degree on the Earth and Sea in our known *Meaſure*; and eſpecially in *Eaſt-Indian* Voyages; ſayling from the *Lizard* in

in the West part of *England* to *Cape de bonne Esperaunce* in *Africke*, they have opportunity of making an ample Experiment hereof.

But leaving this to the practice of the skilfull and industrious *Sea-man*, we come now to shew an orderly and exact way of framing and keeping a reckoning at Sea: for which purpose I have made the *Table* following, which sheweth how much a ship is more Northerly or Southerly, and how much more Easterly or Westerly, by sailing upon any point or half point of the *Compasse*, any number of miles proposed.

The like *Table* I made many years since, and taught the use of it in *Navigation*, whether it were then used by any other, I know not, I had it of no man; but this I speak, that if any man claim the first making and use of such an one, he may have it.

The ground of making this Table is the same with the former. *For as Radius is in proportion to the Distance run, So is the sine complement of the Rumb, to the distance of North or South, and so is the sine of the Rumb, to the distance of East or West.* Therefore here for ten miles upon any of the four points from the *Meridian*, we set in the second column the sine complement of that point (reduced into Degrees) and in the third the sine thereof. As the second Rumb or point from the Meridian, being 22 deg. 30 min. the sine complement thereof which is 9239 set in the second column against 10: and the sine thereof 3827, I set there in the third column; and having done thus, for ten miles in every column, the rest may be easily drawn from them.

As in the second column, for the first half point against 10 miles finding 9952, I set the half thereof; namely 4976 against 5 miles, and the tenth part thereof, namely 995 against 1 mile, which doubled or added to it self is 1990, to be set against two miles, whereto adding the same 995, the sum is 2985 for three miles, and so for the rest.

And thus for every point and half point from the *Meridian*, there are three columns: In the first whereof there is set down a number of miles runne upon that point or half point; the second sheweth how much the *Latitude* is altered; that

is how much you are more Southerly or Northerly, by running ſo farre upon that point or half point; The third, how much you are more Eaſterly or Weſterly, by running that courſe and diſtance.

The Numbers ſet in every firſt coluum from 1 to 10, are alſo to be underſtood from 10 to 100, or from 100 to 1000, and the Figure in the fourth place of the ſecond and third columns, anſwer to the figure in the firſt. As admit a ſhip run South and by Weſt (that is (South 1 point Weſterly) 165 miles) I ſet down this number thus; and looking in the Columns of the firſt *Rumb* againſt 10, (which may be underſtood to be 100) I find againſt it in the ſecond column 981 almoſt, and in the third 195, alſo againſt 60 (that is 6) in the firſt column, there is 588 in the ſecond, and 117 in the third: alſo againſt 5 in the firſt column, there is 49 in the ſecond, and almoſt 10 in the third.

	100	981	195
S. W. 1.	60	588	117
p: & *s.*	5	49	10
	165	161.8	32.2

Theſe ſet down, and ſumm'd up, as here appeareth, ſhew that a Ship running *S* by *W* 165 miles, is to the Southwards of the place from whence ſhe departed 161 miles and 8 tenth parts of a mile, and to the Weſtwards 32 miles, and 2 tenth parts of a mile. If you deſire more exactneſſe you may uſe all the places, for the firſt or greateſt number, which is here 100.

	100	9808	1950
S. W. 1.	60	5885	1170
point.	5	490	97
	165.	161.83	32.17

As in the ſecond Example, where the Southerly diſtance is 161 $\frac{83}{100}$ miles, and the Weſterly 32 $\frac{17}{100}$ miles.

A Table

A Table of the Northing or Southing, Easting or Westing of every Rumb and half Rumb from the Meridian; according to the number of Miles run upon that Rumb.

M.	½ poin. 5.37½	7½ poin. 24 22½	1 poin. 11.15	7 point 78.45	1½ poin 16.52	6½ poin 73. 7½	2 poin. 22. 30	6 poin. 67. 30
1	905	98	981	195	957	290	924	383
2	1990	196	1962	390	1914	580	1848	766
3	2986	294	2943	585	2871	870	2772	1148
4	3981	392	3923	780	3827	1161	3696	1531
5	4976	490	4904	975	4784	1451	4620	1914
6	5971	588	5885	1170	5741	1741	5544	2297
7	6966	686	6866	1365	6698	2031	6468	2680
8	7961	784	7846	1560	7655	2321	7392	3062
9	8957	882	8827	1755	8612	2612	8315	3445
10	9952	980	9608	1950	9569	2902	9239	3827

M	2½ poi. 28. 7½	5½ poin. 61.52½	3 poin. 33.45	5 poi. 56.15	3½ poi. 39.22½	4½ poi. 50.37½	4 poi. 45.00	4 poi. 45.00
1	882	471	831	556	773	634	707	707
2	1764	942	1663	1111	1546	1269	1414	1414
3	2646	1414	2494	1667	2319	1903	2121	2121
4	3528	1885	3326	2222	3092	2538	2828	2828
5	4410	2357	4158	2778	3865	3172	3535	3535
6	5292	2828	4989	3334	4638	3806	4242	4242
7	6174	3300	5820	3890	5411	4440	4949	4949
8	7056	3771	6652	4445	6184	5075	5656	5656
9	7937	4243	7483	5000	6957	5710	6364	6364
10	8819	4714	8315	5556	7730	6344	7071	7071

A larger Example may be that before set down in the last *Problems* of Sailing by a *Great Circle* from *Summer-Islands* to the *Lizard*, pag. 127.

As

As admit I ſail from thence: Firſt, *N E* ½ point Eaſterly 600 miles, then *N E by E* 300 miles; Eaſt North-eaſt half a point Northerly 495 miles; Eaſt *N E* 390 miles; *E N E*, ½ point Eaſterly 264 miles; *E* by *N* 210 miles; Eaſt 951 miles: Theſe Courſes and Diſtances I ſet down in ſuch form as here appeareth, where in the firſt column there is expreſſed the Courſe or point of the Compaſſe upon which a man ſails: In the ſecond column, the Diſtance of thrt *Rumb* from the *Meridian*: In the third column, the Diſtance run upon that *Point*; In the reſt, the difference of *Latitude*, and departure from the *Meridian* in miles and *tenth* parts of a mile.

Courſe	*Rumb frõ me.*	*Diſt. miles.*	*North.*	*South*	*Eaſt*	*Weſt*
N E ½ *Po. E.*	*North Eaſterly* 4½ *P.*	600	380.6		463.8	
N E by E.	*N Eaſt* 5 *Point*	300	166.7		2494	
E N E ½ *Po. N.*	*N Eaſt* 5½ *Po.*	400 90 5	1885 424 24		3528 794 44	
E N E	*N Eaſt* 6 *Po.*	300 90	1148 344		277.2 831	
E N E ½ *Po. E.*	*N Eaſt* 6½ *Po.*	200 60 4	580 174 12		1914 574 38	
E by N	*N Eaſt* 7 *Po.*	100 10 9 00	390 20		1962 98 9510	
Eaſt	*Eaſt*	50 1				
		3210	1047.4		29197	

(In

(In all which is to be conceived, that the *Variations* are allowed) ſo that at the Foot of this reckoning, I finde the ſumms of the North column to be 1047, $\frac{4}{5}$ miles, and the ſumme of the Eaſt column 2920 miles almoſt; the firſt, namely 1047 miles converted into degrees, is 17 degrees, 27 min. the difference of Latitude, which added to the Latitude of *Summer-Iſlands* 32 deg. 25 min. (where this reckoning began) the ſumme is 49 deg. 52 min. which is the Latitude of this laſt place where this reckoning endeth. So that according to this account, the Ship is run into the Latitude of 49 deg. 52 min. and hath altered her Longitude to the Eaſtwards 2920 miles, of ſuch miles, whereof 60 make a degree of a great Circle.

Therefore, if you ſet down this reckoning on the *Plain Chart*, you muſt make a point in the *Chart* that may be in the Latitude of 49 deg. 52 min. and to the Eaſtwards of *Summer-Iſlands*, (where this reckoning began) 2920 miles, that is, you muſt run a parallel (with your Compaſſes or otherwiſe) on your *Chart* in the Latitude of 49 degrees 52 minutes, and croſſe the ſame by a Meridian, which may be to the Eaſtwards of the Meridian of *Summer-Iſlands* 2920 miles, and ſo the point of the interſection of this parallel and Meridian, is the Traverſe-point or point in the *Chart*, repreſenting the place where the Ship is in the end of this Reckoning.

But if you ſet down this reckoning on *Mercators Chart*, you muſt alſo finde a point that may be in the Latitude of 29 deg. 52 min. and may likewiſe be to the Eaſtwards of *Summer-Iſlands* 2920 miles, which is done by running with your compaſſes a parallel in the Latitude of 49 deg. 52 min. and croſſing the ſame by a *Meridian*, which may be to the Eaſtwards of the *Meridian* of *Summer-Iſlands* 2920 miles, the point of the interſection of this parallel with that *Meridian* is the traverſe point, repreſenting in the *Chart* the place where the ſhip then is.

For it is to be conceived in this *Chart*, that the degrees of the *Meridian* intercepted between the Latitudes of two places are as a Scale for thoſe two places, to meaſure not onely their difference of *Latitude*, but likewiſe their diſtance in their *Rumb*, as alſo the diſtance of their *Meridians*.

But

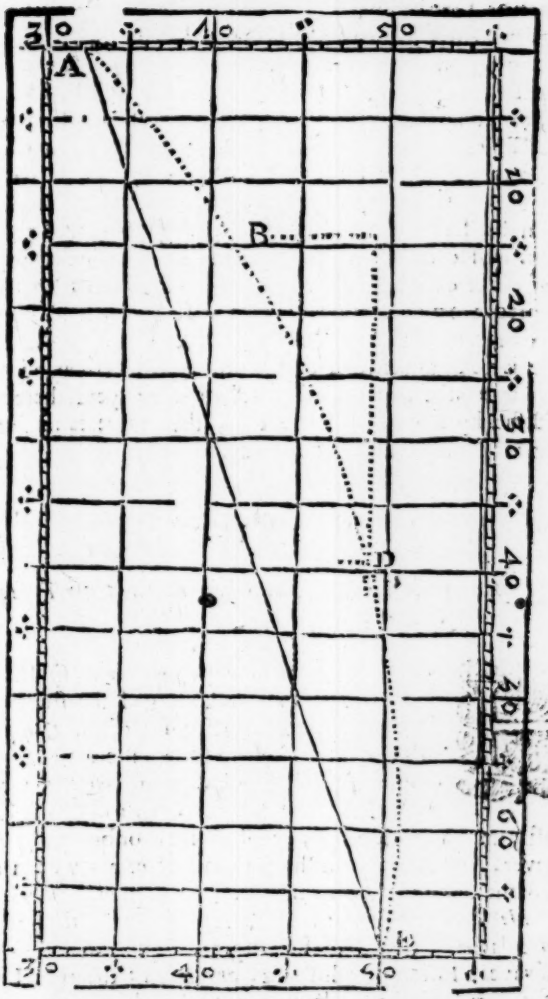
But becauſe it often falls out, that in ſailing from place to place, a ſhip runs not near the Rumb of the two places by many hundred miles, eſpecially in ſailing by the Arch of a *Great Circle*, which is the moſt exquiſite manner of ſailing, and wherein a man ſhifts his Courſe often, and runs much farther in one Latitude then in another, as by the former example may appear. Therefore once in three or four daies, or ſo often as you alter your Courſe much, you may transfer or ſet down your Reckoning out of your Book into your *Chart*. As in transferring the former example, you may ſet down the Northing and Eaſting of every of the Courſes ſeverally; but for brevities ſake will bring them into three parts (and ſo alſo we ſhall not much erre.)

And thus for the two firſt Courſes, namely *N E* ½ point Eaſterly 600 miles, and *N E by E* 300 miles, I find in the North column 547 miles; and in the Eaſt column 713 miles: alſo for the three next Courſes ſumming up the North and Eaſt columns, I finde the Northing, to be 459 miles, and the Eaſting 1050 miles. Alſo for the two laſt Courſes, I finde the Northing to be 41 miles, and the Eaſting 1157 miles.

North	*Eaſt.*
547	713
459	1050
41	1137
1047	2920

Now to transfer theſe into the *Chart*, I conſider that 547 miles is 9 degrees 7 minutes, which added to the former *L*atitude 32 deg. 25 min. makes latitude 41 deg. 32 min. In which *L*atitude I run a parallel, then conſidering that 713 miles is 11 deg. 53 min. I take this 11 deg. 53 min. in the *M*eridian, as much above the one *L*atitude, as beneath the other, namely, from 31 deg. 0 min. to 42 degrees 53 minutes, and this I ſet in the foreſaid parallel from the *M*eridian of *Summers-Iſlands* to the Eaſtwards, and there make the point B, then reducing 459 miles into deg. it makes 7 deg. 39 min. which added to 41 deg. 32 min. makes *L*atitude 49 deg. 11 min. Alſo the Eaſting 1050 miles are 17 deg. 30 min. the half whereof 8 deg. 45 min. I take in the *M*eridian from above 41 deg. 32 min. beneath 49 deg. 11 minutes, namely, from 41 deg. 20 min. to 50 deg. 5 min. And this being doubled (becauſe it is but the half) I ſet from the *M*eridian of

the



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the prick or Traverſe-point B before made, in the Parallel of 49 d. g. 11 min. making there another prick D. Laſtly, I adde the Northing 41 miles to the former Latitude 49 degrees 11 min. the ſumme is 49 deg. 52 min. the Latitude of the Parallel, to which I am now come, wherein I am to ſet down the Eaſting 1157 miles: This therefore converted into degrees of a *Great Circle*, make 19 deg. 17 min. I take therefore one degree of the meridian, about that Latitude of 49 deg. 52 min. (becauſe the moſt part is run in that Latitude) namely, from 49 deg. 30 min. to 50 deg. 30 min. and ſet the ſame in the foreſaid Parallel from the meridian of the prick D laſt before made to the Eaſtwards 19 times, and moreover 17 min. taken at the ſame Latitude, and this reacheth to the point E. And ſo is all this reckoning ſet down, and the like is to be underſtood of any other, which though in expreſſion it require many words for plainneſſe; yet is there very little difficulty more in the Practiſe, then there is in ſetting down a reckoning on the *Plain Chart*.

CHAP. IX.

A more ample Example, together with a larger Table for the keeping a reckoning at Sea.

HAving thus (in a more general manner) ſhewed how to ſet down a reckoning of the ſhips way, for every point and half point of the *Compaſſe*, this to ſome men might ſeem ſufficient: But becauſe a ſhip doth not alwayes make her way good as ſhe lies, nor doth her *Leeward*-way alwayes fall juſtly upon a whole point, or half point, or quarter; And moreover, conſidering that though a ſhip ſteer away upon any point of the Compaſſe, yet her true way, by reaſon of the *Variation of the Needle*, may ſwerve from that point towards the one ſide or towards the other, three or four degrees, or more or leſſe, and not alwayes a Point, or half Point, or quarter: therefore I have thought it requiſite to ſet down the Table following to every ſingle

ſingle Degree: and that a man might the more readily with one or two Entrances have his deſire, I have alſo enlarged the number of miles unto 100. The ground and way of making this Table differs not from the former, and it is to be uſed almoſt in the ſelf-ſame manner: wherefore we ſhall uſe the more brevity in handling of it.

Here followeth a Table of the Northing or Southing, Eaſting or Weſting of every Degree from the Meridian, according to the number of Miles run upon that Degree, which for brevity ſake we will call —

A TABLE For the DIFFERENCE OF LATITVDE, AND Departure from the *Meridian.*

M	1 d.	89 d.	M	1 d.	89 d.	Min.	1 d.	89 d.
1	10	0	35	350	6	69	690	12
2	20	0	36	360	7	70	700	12
3	30	0	37	370	7	71	710	13
4	40	1	38	380	7	72	720	13
5	50	1	39	390	7	73	730	13
6	60	1	40	400	7	74	740	13
7	70	1	41	410	7	75	750	13
8	80	1	42	420	7	76	760	13
9	90	2	43	430	8	77	770	14
10	100	2	44	440	8	78	780	14
11	110	2	45	450	8	79	790	14
12	120	2	46	460	8	80	800	14
13	130	2	47	470	8	81	810	14
14	140	2	48	480	9	82	820	14
15	150	3	49	490	9	83	830	15
16	160	3	50	500	9	84	840	15
17	170	3	51	510	9	85	850	15
18	180	3	52	520	9	86	860	15
19	190	3	53	530	9	87	870	15
20	200	4	54	540	10	88	880	15
21	210	4	55	550	10	89	890	16
22	220	4	56	560	10	90	900	16
23	230	4	57	570	10	91	910	16
24	240	4	58	580	10	92	920	16
25	250	4	59	590	10	93	930	16
26	260	5	60	600	11	94	940	17
27	270	5	61	610	11	95	950	17
28	280	5	62	620	11	96	960	17
29	290	5	63	630	11	97	970	17
30	300	5	64	640	11	98	980	17
31	310	5	65	650	12	99	990	17
32	320	6	66	660	12	100	1000	18
33	330	6	67	670	12	200	2000	35
34	340	6	68	680	12	300	3000	53

M	2 d.	88d
1	10	0
2	20	1
3	30	1
4	40	1
5	50	2
6	60	2
7	70	2
8	80	3
9	90	3
10	100	3
11	110	4
12	120	4
13	130	4
14	140	5
15	150	5
16	160	6
17	170	6
18	180	6
19	190	7
20	200	7
21	210	7
22	220	8
23	230	8
24	240	8
25	250	9
26	260	9
27	270	9
28	280	10
29	290	10
30	300	10
31	310	11
32	320	11
33	330	11
34	340	12
35	350	12
36	360	13
37	370	13
38	380	13
39	390	14
40	400	14
41	410	14
42	420	15
43	430	15
44	440	15
45	450	16
46	460	16
47	470	16
48	480	17
49	490	17
50	500	17
51	510	18
52	520	18
53	530	18
54	540	19
55	550	19
56	560	19
57	570	20
58	580	20
59	590	20
60	600	21
61	610	21
62	620	22
63	630	22
64	640	22
65	650	23
66	660	23
67	670	23
68	680	24
69	690	24
70	700	24
71	710	25
72	720	25
73	730	25
74	740	26
75	750	26
76	760	26
77	770	27
78	780	27
79	790	28
80	800	28
81	809	28
82	819	29
83	829	29
84	839	29
85	849	30
86	859	30
87	869	30
88	879	31
89	889	31
90	899	31
91	909	32
92	919	32
93	929	32
94	939	33
95	949	33
96	959	34
97	969	34
98	979	34
99	989	35
100	999	35
200	1999	70
300	2998	105

M	3d.	87 d.	M	3 d.	87d	Min.	3 d.	87 d.
1	10	1	35	350	18	69	689	36
2	20	1	36	360	19	70	699	37
3	30	1	37	370	19	71	709	37
4	40	2	38	380	20	72	719	38
5	50	2	39	390	20	73	729	38
6	60	3	40	400	21	74	739	39
7	70	4	41	410	21	75	749	39
8	80	4	42	420	22	76	759	40
9	90	5	43	430	22	77	769	40
10	100	5	44	440	23	78	779	41
11	110	6	45	450	23	79	789	41
12	120	6	46	460	24	80	799	42
13	130	7	47	470	24	81	809	42
14	140	7	48	480	25	82	819	43
15	150	8	49	490	26	83	829	43
16	160	8	50	500	26	84	839	44
17	170	9	51	509	27	85	849	44
18	180	9	52	519	27	86	859	45
19	190	10	53	529	28	87	869	45
20	200	10	54	539	28	88	879	46
21	210	11	55	549	29	89	889	46
22	220	11	56	559	29	90	899	47
23	230	12	57	569	30	91	909	48
24	240	12	58	579	30	92	919	48
25	250	13	59	589	31	93	929	49
26	260	13	60	599	31	94	939	49
27	270	14	61	609	32	95	949	50
28	280	15	62	619	32	96	959	50
29	290	15	63	629	33	97	969	51
30	300	16	64	639	33	98	979	51
31	310	16	65	649	34	99	989	52
32	320	17	66	659	35	100	999	52
33	330	17	67	669	35	200	1997	105
34	340	18	68	679	36	300	2996	157

M.	4 d.	86d	M	4 d.	86d	Min.	4 d.	88 d.
1	10	1	35	349	25	69	688	48
2	20	1	36	359	25	70	698	49
3	30	2	37	369	26	71	708	50
4	40	3	38	379	27	72	718	50
5	50	3	39	389	27	73	728	51
6	60	4	40	399	28	74	738	52
7	70	5	41	409	29	75	748	52
8	80	6	42	419	29	76	758	53
9	90	6	43	429	30	77	768	54
10	100	7	44	439	31	78	778	55
11	110	8	45	449	31	79	788	55
12	120	8	46	459	32	80	798	56
13	130	9	47	469	33	81	808	57
14	140	10	48	479	34	82	818	57
15	150	10	49	489	34	83	828	58
16	159	11	50	499	35	84	838	59
17	169	12	51	509	36	85	848	59
18	179	13	52	519	36	86	858	60
19	189	13	53	529	37	87	868	61
20	199	14	54	539	38	88	878	61
21	209	15	55	549	38	89	888	62
22	219	15	56	559	39	90	898	63
23	229	16	57	569	40	91	908	63
24	239	17	58	579	40	92	918	64
25	249	17	59	589	41	93	928	65
26	259	18	60	599	42	94	938	66
27	269	19	61	609	43	95	948	66
28	279	20	62	610	43	96	958	67
29	289	20	63	629	44	97	968	68
30	299	21	64	639	45	98	978	68
31	309	22	65	648	45	99	988	69
32	319	22	66	658	46	100	998	70
33	329	23	67	668	47	200	1995	140
34	339	24	68	678	48	300	2983	209

M	5 d.	85 d.	M	5 d.	85 d.	Min.	5 d.	85 d.
1	10	1	35	349	30	69	687	60
2	20	2	36	359	31	70	697	61
3	30	3	37	369	32	71	707	62
4	40	3	38	379	33	72	717	63
5	50	4	39	388	34	73	727	64
6	60	5	40	398	35	74	737	65
7	70	6	41	408	36	75	747	65
8	80	7	42	418	37	76	757	66
9	90	8	43	428	37	77	767	67
10	100	9	44	438	38	78	777	68
11	110	10	45	448	39	79	787	69
12	120	10	46	458	40	80	797	70
13	130	11	47	468	41	81	807	71
14	140	12	48	478	42	82	817	71
15	150	13	49	488	43	83	827	72
16	159	14	50	498	44	84	837	73
17	169	15	51	508	45	85	847	74
18	179	16	52	518	45	86	857	75
19	189	17	53	528	46	87	867	76
20	199	17	54	538	47	88	877	77
21	209	18	55	548	48	89	887	78
22	219	19	56	558	49	90	897	78
23	229	20	57	568	50	91	907	79
24	239	21	58	578	51	92	916	80
25	249	22	59	588	52	93	926	81
26	259	23	60	598	52	94	936	82
27	269	24	61	608	53	95	946	83
28	279	24	62	618	54	96	956	84
29	289	25	63	628	55	97	966	84
30	299	26	64	638	56	98	976	85
31	309	27	65	648	57	99	986	86
32	319	28	66	658	58	100	996	87
33	329	29	67	668	58	200	1992	174
34	339	30	68	677	59	300	2989	262

M	6 d.	84 p.	M	6 d.	84 d.	Min.	6 d.	84 d.
1	10	1	35	348	36	69	686	72
2	20	2	36	358	38	70	696	73
3	30	3	37	368	39	71	706	74
4	40	4	38	378	40	72	716	75
5	50	5	39	388	41	73	726	76
6	60	6	40	398	42	74	736	77
7	70	7	41	408	43	75	746	78
8	80	8	42	418	44	76	756	79
9	89	9	43	428	45	77	766	80
10	99	10	44	438	46	78	776	81
11	109	11	45	447	47	79	786	82
12	119	12	46	457	48	80	796	83
13	129	14	47	467	49	81	806	85
14	139	15	48	477	50	82	815	86
15	149	16	49	487	51	83	825	87
16	159	17	50	497	52	84	835	88
17	169	18	51	507	53	85	845	89
18	179	19	52	517	54	86	855	90
19	189	20	53	527	55	87	865	91
20	199	21	54	537	56	88	875	92
21	209	22	55	547	57	89	885	93
22	219	23	56	557	58	90	895	94
23	229	24	57	567	59	91	905	95
24	239	25	58	577	61	92	915	96
25	249	26	59	587	62	93	925	97
26	259	27	60	597	63	94	935	98
27	268	28	61	607	64	95	945	99
28	278	29	62	617	65	96	955	100
29	288	30	63	627	66	97	965	101
30	298	31	64	637	67	98	975	102
31	308	32	65	646	68	99	985	103
32	318	33	66	656	69	100	995	104
33	328	34	67	666	70	200	1989	209
34	338	35	68	676	71	300	2983	313

M	7 d	83 d.
1	10	1
2	20	2
3	30	4
4	40	5
5	50	6
6	60	7
7	69	8
8	79	10
9	89	11
10	99	12
11	109	13
12	119	15
13	129	16
14	139	17
15	149	18
16	159	20
17	169	21
18	179	22
19	189	23
20	199	24
21	208	26
22	218	27
23	228	28
24	238	29
25	248	30
26	258	32
27	268	33
28	278	34
29	288	35
30	298	37
31	308	38
32	318	39
33	327	40
34	337	41

M	7 d.	83 d
35	347	43
36	357	44
37	367	45
38	377	46
39	387	48
40	397	49
41	407	50
42	417	51
43	427	52
44	437	54
45	447	55
46	456	56
47	466	57
48	476	59
49	486	60
50	496	61
51	506	62
52	516	63
53	526	65
54	536	66
55	546	67
56	556	68
57	566	69
58	576	71
59	586	72
60	596	73
61	605	74
62	615	76
63	625	77
64	635	78
65	645	79
66	655	81
67	665	82
68	675	83

Min.	7 d.	83 d.
69	685	84
70	695	85
71	705	87
72	715	88
73	725	89
74	734	90
75	744	92
76	754	93
77	764	94
78	774	95
79	784	96
80	794	98
81	804	99
82	814	100
83	824	101
84	834	103
85	844	104
86	854	105
87	863	106
88	873	107
89	883	109
90	893	110
91	903	111
92	913	112
93	923	113
94	933	115
95	943	116
96	953	117
97	963	118
98	973	120
99	983	121
100	993	122
200	1985	244
300	2977	366

M	8 d.	82d	M	8d.	82d	Min.	8 d.	82 d.
1	10	1	35	347	49	69	683	96
2	20	3	36	357	50	70	693	97
3	30	4	37	366	51	71	703	99
4	40	6	38	376	53	72	713	100
5	50	7	39	386	54	73	723	102
6	59	8	40	396	56	74	733	103
7	69	10	41	406	57	75	743	104
8	79	11	42	416	58	76	753	106
9	89	13	43	426	60	77	763	107
10	99	14	44	436	61	78	772	109
11	109	15	45	446	63	79	782	110
12	119	17	46	456	64	80	792	111
13	129	18	47	465	65	81	802	113
14	139	19	48	475	67	82	812	114
15	148	21	49	485	68	83	822	115
16	158	22	50	495	70	84	832	117
17	168	24	51	505	71	85	842	118
18	178	25	52	515	72	86	852	120
19	188	26	53	525	74	87	862	121
20	198	28	54	535	75	88	872	122
21	208	29	55	545	77	89	881	124
22	218	31	56	555	78	90	891	125
23	228	32	57	565	79	91	901	127
24	238	33	58	574	81	92	911	128
25	248	35	59	584	82	93	921	129
26	257	36	60	594	83	94	931	131
27	267	38	61	604	85	95	941	132
28	277	39	62	614	86	96	951	134
29	287	40	63	624	88	97	961	135
30	297	42	64	634	89	98	970	136
31	307	43	65	644	90	99	980	138
32	317	44	66	654	92	100	990	139
33	327	46	67	664	93	200	1981	278
34	337	47	68	673	95	300	2971	418

M	9 d	81 d.
1	10	2
2	20	3
3	30	5
4	40	6
5	49	8
6	59	9
7	69	11
8	79	13
9	89	14
10	99	16
11	109	17
12	119	19
13	129	20
14	138	22
15	148	23
16	158	25
17	168	26
18	178	28
19	188	30
20	198	31
21	208	33
22	217	34
23	227	36
24	237	37
25	247	39
26	257	41
27	267	42
28	277	44
29	287	45
30	296	47
31	306	48
32	316	50
33	326	51
34	336	53

M	9 d.	81 d
35	346	55
36	356	56
37	366	58
38	375	59
39	385	61
40	395	63
41	405	64
42	415	66
43	425	67
44	435	69
45	445	70
46	454	72
47	464	73
48	474	75
49	484	77
50	494	78
51	504	80
52	514	81
53	524	83
54	534	84
55	543	86
56	553	88
57	563	89
58	573	91
59	583	92
60	593	94
61	603	95
62	612	97
63	622	98
64	632	100
65	642	102
66	652	103
67	662	105
68	672	106

Min.	9 d.	81 d
69	682	108
70	691	109
71	701	111
72	711	112
73	721	114
74	731	116
75	741	117
76	751	119
77	761	120
78	770	122
79	780	124
80	790	125
81	800	127
82	810	128
83	820	130
84	830	131
85	840	133
86	850	134
87	859	136
88	869	138
89	879	139
90	889	141
91	899	142
92	909	144
93	919	145
94	929	147
95	938	148
96	948	150
97	958	152
98	968	153
99	978	155
100	988	156
200	1975	213
300	2963	369

M	10d	80 d.	M	10d	80d	Min.	10 d.	80 d
1	10	2	35	345	61	69	680	120
2	20	3	36	355	62	70	689	121
3	20	5	37	365	64	71	699	123
4	39	7	38	374	66	72	709	125
5	49	9	39	384	69	73	719	127
6	59	10	40	394	69	74	729	128
7	69	12	41	404	71	75	739	130
8	79	14	42	414	73	76	749	132
9	89	16	43	424	75	77	758	133
10	99	17	44	433	76	78	768	135
11	108	19	45	443	78	79	778	137
12	118	21	46	453	80	80	788	139
13	128	23	47	463	81	81	798	141
14	138	24	48	473	83	82	807	142
15	148	26	49	483	85	83	817	144
16	158	28	50	492	87	84	827	146
17	168	30	51	502	88	85	837	148
18	177	31	52	512	90	86	847	149
19	187	33	53	522	92	87	857	151
20	197	35	54	532	94	88	867	153
21	207	36	55	542	95	89	876	154
22	217	38	56	552	97	90	886	156
23	227	40	57	561	99	91	896	158
24	236	42	58	571	101	92	906	160
25	246	43	59	581	102	93	916	161
26	256	45	60	591	104	94	926	163
27	266	47	61	601	106	95	936	165
28	276	49	62	611	108	96	946	167
29	286	50	63	620	109	97	955	168
30	296	52	64	630	111	98	965	170
31	305	54	65	640	113	99	975	172
32	315	55	66	650	115	100	985	174
33	325	57	67	660	116	200	1970	347
34	335	59	68	670	118	300	2954	521

M	11d	79 d.	M	11d	79d	Min.	11 d.	77 d.
1	10	2	35	343	67	69	677	132
2	20	4	36	353	69	70	687	134
3	29	6	37	363	71	71	697	135
4	39	8	38	373	72	72	707	137
5	49	9	39	383	74	73	716	139
6	59	11	40	393	76	74	726	141
7	69	13	41	402	78	75	736	143
8	78	15	42	412	80	76	746	145
9	88	17	43	422	82	77	756	147
10	98	19	44	432	84	78	765	149
11	108	21	45	442	86	79	775	151
12	118	23	46	452	88	80	785	153
13	128	25	47	461	90	81	795	154
14	137	27	48	471	92	82	805	156
15	147	29	49	481	93	83	815	158
16	157	30	50	491	95	84	824	160
17	167	32	51	501	97	85	834	162
18	177	34	52	510	99	86	844	164
19	186	36	53	520	101	87	854	166
20	196	38	54	530	103	88	864	168
21	206	40	55	540	105	89	873	170
22	216	42	56	550	107	90	883	172
23	226	44	57	559	109	91	893	174
24	236	46	58	569	111	92	903	176
25	245	48	59	579	112	93	913	177
26	255	50	60	589	114	94	923	179
27	265	51	61	599	116	95	932	181
28	275	53	62	609	118	96	942	183
29	285	55	63	618	120	97	952	185
30	294	57	64	628	122	98	962	187
31	304	59	65	638	124	99	972	189
32	314	61	66	648	126	100	981	191
33	324	63	67	658	128	200	1963	382
34	334	65	68	668	130	300	2944	572

M	12d	78 d.	M	12d	78d	Min.	12 d	78 d
1	10	2	35	342	73	69	675	144
2	20	4	36	352	75	70	685	146
3	29	6	37	362	77	71	694	148
4	39	8	38	372	79	72	704	150
5	49	10	39	381	81	73	714	152
6	59	12	40	391	83	74	724	154
7	68	15	41	401	85	75	734	156
8	78	17	42	411	87	76	743	158
9	88	19	43	420	90	77	753	160
10	98	21	44	430	92	78	763	162
11	108	23	45	440	94	79	773	164
12	117	25	46	450	96	80	783	166
13	127	27	47	460	98	81	792	168
14	137	29	48	470	100	82	802	170
15	147	31	49	479	102	83	812	173
16	156	33	50	489	104	84	822	175
17	166	36	51	499	106	85	831	177
18	176	38	52	509	108	86	841	179
19	186	40	53	518	110	87	851	181
20	196	42	54	528	112	88	861	183
21	205	44	55	538	114	89	871	185
22	215	46	56	548	116	90	880	187
23	225	48	57	558	118	91	850	189
24	235	50	58	567	121	92	900	191
25	245	52	59	577	123	93	910	193
26	254	54	60	587	125	94	920	195
27	264	56	61	597	127	95	929	197
28	274	58	62	607	129	96	939	200
29	284	60	63	616	131	97	949	202
30	293	62	64	626	133	98	959	204
31	303	64	65	636	135	99	968	206
32	313	66	66	646	137	100	978	208
33	323	69	67	655	140	200	1956	416
34	333	71	68	665	142	300	2934	624

M	13 d.	77 d.	M	13 d.	77 d.	Min.	13 d.	77 d.
1	10	2	35	341	79	69	672	155
2	20	4	36	351	81	70	68	157
3	29	7	37	361	83	71	692	160
4	39	9	38	370	86	72	702	162
5	49	11	39	380	88	73	711	164
6	59	13	40	390	90	74	721	166
7	68	16	41	400	92	75	731	169
8	78	18	42	409	94	76	741	171
9	88	20	43	419	97	77	750	173
10	98	22	44	429	99	78	760	175
11	107	25	45	438	101	79	770	178
12	117	27	46	448	103	80	780	180
13	127	29	47	458	106	81	789	182
14	136	31	48	468	108	82	799	184
15	146	34	49	477	110	83	809	187
16	156	36	50	487	112	84	818	189
17	166	38	51	497	115	85	828	191
18	176	40	52	507	117	86	838	193
19	185	43	53	516	119	87	848	196
20	195	45	54	526	121	88	857	198
21	205	47	55	536	124	89	867	200
22	215	49	56	546	126	90	877	202
23	224	52	57	555	128	91	887	205
24	234	54	58	565	130	92	896	207
25	244	56	59	575	133	93	906	209
26	254	58	60	585	135	94	916	211
27	263	61	61	594	137	95	926	214
28	273	63	62	604	140	96	935	216
29	283	65	63	614	142	97	945	218
30	292	67	64	624	144	98	955	221
31	302	70	65	634	146	99	965	223
32	312	72	66	643	148	100	974	225
33	322	74	67	653	151	200	1949	450
34	331	76	68	663	153	300	2923	675

M	14d	76 d.	M	14d	76d	Min.	14 d.	76 d.
1	10	2	35	340	85	69	669	167
2	19	5	36	349	87	70	679	169
3	29	7	37	359	90	71	689	172
4	39	10	38	369	92	72	698	174
5	48	12	39	378	94	73	708	177
6	58	14	40	388	97	74	718	179
7	68	17	41	398	99	75	728	182
8	78	19	42	407	102	76	737	184
9	87	22	43	417	104	77	747	187
10	97	24	44	427	107	78	756	189
11	107	27	45	437	109	79	766	191
12	116	29	46	446	111	80	776	194
13	126	31	47	456	114	81	786	195
14	136	34	48	466	116	82	796	197
15	146	36	49	475	119	83	805	200
16	155	39	50	485	121	84	815	202
17	165	41	51	495	123	85	825	205
18	175	44	52	504	126	86	834	207
19	184	46	53	514	138	87	844	209
20	194	48	54	524	131	88	854	213
21	204	51	55	534	133	89	864	215
22	213	53	56	543	136	90	873	218
23	223	56	57	553	138	91	883	220
24	233	58	58	563	140	92	893	223
25	242	60	59	572	143	93	902	225
26	252	63	60	582	145	94	912	227
27	262	65	61	592	148	95	921	230
28	272	68	62	601	150	96	931	232
29	281	70	63	611	153	97	941	235
30	291	73	64	621	155	98	951	237
31	301	75	65	631	157	99	960	240
32	310	77	66	640	160	100	970	242
33	320	80	67	650	162	200	1941	484
34	330	82	68	660	165	300	2911	726

M	15d	75d
1	10	3
2	19	5
3	29	8
4	39	10
5	48	13
6	58	16
7	68	18
8	77	21
9	87	23
10	97	26
11	106	28
12	116	31
13	126	34
14	135	36
15	145	39
16	155	41
17	164	44
18	174	47
19	183	49
20	193	52
21	203	54
22	213	57
23	222	60
24	232	62
25	242	65
26	251	67
27	261	70
28	271	73
29	280	75
30	290	78
31	299	80
32	309	83
33	319	85
34	328	88

M	15d	75d
35	338	91
36	348	93
37	357	96
38	367	98
39	377	101
40	386	103
41	396	106
42	406	109
43	415	111
44	425	114
45	435	116
46	444	119
47	454	123
48	464	125
49	473	128
50	483	129
51	493	132
52	502	135
53	512	137
54	522	140
55	531	142
56	541	145
57	551	148
58	560	150
59	570	153
60	580	155
61	589	158
62	599	160
63	608	163
64	618	166
65	628	168
66	638	171
67	647	174
68	657	176

Mm.	15 d.	75 d.
69	666	179
70	676	181
71	686	184
72	696	186
73	705	189
74	715	192
75	724	194
76	734	197
77	744	200
78	754	202
79	763	205
80	773	207
81	783	210
82	792	212
83	802	215
84	811	217
85	821	220
86	831	223
87	840	225
88	850	228
89	860	230
90	869	233
91	879	236
92	889	238
93	898	241
94	908	243
95	918	246
96	927	248
97	937	251
98	947	254
99	956	256
100	966	259
200	1932	518
300	2898	776

M	16d	74 d.	M	16d	74d	Min.	16 d.	74 d.
1	10	3	35	336	97	69	663	190
2	19	6	36	346	99	70	673	193
3	29	8	37	356	102	71	682	196
4	38	11	38	365	105	72	692	199
5	48	14	39	375	107	73	702	201
6	58	17	40	384	110	74	711	204
7	67	19	41	394	113	75	721	207
8	77	22	42	404	116	76	731	210
9	86	25	43	413	119	77	740	213
10	96	28	44	423	121	78	750	215
11	106	30	45	432	124	79	759	218
12	115	33	46	442	127	80	769	220
13	125	36	47	452	130	81	779	223
14	134	39	48	461	132	82	788	226
15	144	41	49	471	135	83	798	229
16	154	44	50	481	138	84	807	232
17	163	47	51	490	141	85	817	235
18	173	50	52	500	143	86	827	237
19	183	53	53	509	146	87	836	240
20	192	55	54	519	149	88	846	243
21	202	58	55	529	151	89	856	245
22	211	61	56	538	154	90	865	248
23	221	63	57	548	157	91	875	251
24	231	66	58	557	160	92	884	254
25	240	69	59	567	163	93	894	257
26	250	72	60	577	165	94	904	259
27	259	75	61	586	168	95	913	262
28	269	77	62	596	171	96	923	265
29	279	80	63	606	174	97	932	267
30	288	83	64	615	177	98	942	270
31	298	85	65	625	179	99	952	273
32	308	88	66	634	182	100	961	276
33	317	91	67	644	185	200	1923	551
34	327	94	68	654	188	300	2884	827

M	17d	73d	M	17d	73d	Min.	17 d.	73 d.
1	10	3	35	335	102	69	660	202
2	19	6	36	344	105	70	669	205
3	29	9	37	354	108	71	679	207
4	38	12	38	363	111	72	688	210
5	48	15	39	373	114	73	698	213
6	57	17	40	383	117	74	708	216
7	67	20	41	392	120	75	717	219
8	76	23	42	402	123	76	727	222
9	86	26	43	411	126	77	736	225
10	96	29	44	421	129	78	746	228
11	105	32	45	430	131	79	755	231
12	115	35	46	440	134	80	765	234
13	124	38	47	449	137	81	775	237
14	134	41	48	459	140	82	784	240
15	143	44	49	469	143	83	794	243
16	153	47	50	478	146	84	803	246
17	162	50	51	488	149	85	813	248
18	172	52	52	497	152	86	822	251
19	182	55	53	507	155	87	832	254
20	191	58	54	516	158	88	842	257
21	201	61	55	526	161	89	851	260
22	210	64	56	535	164	90	861	263
23	220	67	57	545	167	91	870	266
24	230	70	58	554	170	92	880	269
25	239	73	59	564	172	93	889	272
26	249	76	60	574	175	94	899	275
27	258	79	61	583	178	95	908	278
28	268	82	62	593	181	96	918	281
29	277	85	63	602	184	97	927	284
30	287	88	64	612	187	98	937	287
31	296	91	65	622	190	99	947	289
32	306	93	66	631	193	100	956	292
33	316	96	67	641	196	200	1913	585
34	325	99	68	650	199	300	2860	877

M	18d	72 d.	M	18d	78d	Min.	18 d.	72 d
1	10	3	35	333	108	69	656	213
2	19	6	36	342	111	70	666	216
3	28	9	37	352	114	71	675	219
4	38	12	38	361	117	72	685	222
5	47	15	39	371	120	73	694	225
6	57	18	40	380	124	74	704	229
7	66	22	41	390	127	75	713	232
8	76	25	42	398	130	76	723	235
9	85	28	43	408	133	77	732	238
10	95	31	44	417	136	78	742	241
11	104	34	45	427	139	79	751	244
12	114	37	46	436	142	80	761	247
13	123	40	47	446	145	81	770	250
14	133	43	48	455	148	82	780	253
15	142	46	49	465	151	83	789	256
16	152	50	50	476	154	84	799	260
17	161	53	51	485	158	85	808	263
18	171	56	52	495	161	86	818	266
19	180	59	53	504	164	87	827	269
20	190	62	54	514	167	88	837	272
21	200	65	55	523	170	89	846	275
22	209	68	56	533	173	90	856	278
23	219	71	57	542	176	91	865	281
24	228	74	58	552	179	92	875	284
25	238	77	59	561	182	93	884	287
26	247	81	60	571	185	94	894	290
27	257	84	61	580	188	95	903	293
28	266	87	62	590	192	96	913	297
29	276	90	63	599	195	97	922	300
30	285	93	64	609	198	98	932	303
31	295	96	65	618	201	99	941	306
32	304	99	66	628	204	100	951	309
33	314	102	67	637	207	200	1902	618
34	323	105	68	647	210	300	2853	927

M	19d	71 d.
1	9	3
2	19	6
3	28	10
4	38	13
5	47	16
6	57	20
7	66	23
8	75	26
9	85	29
10	94	33
11	104	36
12	113	39
13	123	42
14	132	46
15	142	49
16	151	52
17	161	55
18	170	59
19	180	62
20	189	65
21	199	68
22	208	72
23	217	75
24	227	78
25	236	82
26	246	85
27	255	88
28	265	91
29	274	94
30	284	98
31	293	101
32	303	104
33	312	107
34	322	111

M	19d	71d
35	331	114
36	340	117
37	350	121
38	359	124
39	369	127
40	378	130
41	388	134
42	397	137
43	407	140
44	416	143
45	425	147
46	435	150
47	444	153
48	454	156
49	463	160
50	473	163
51	482	166
52	492	169
53	501	173
54	510	176
55	520	179
56	529	182
57	539	186
58	548	189
59	558	192
60	567	195
61	577	199
62	586	202
63	596	205
64	605	208
65	615	212
66	624	215
67	634	218
68	643	222

Min.	19 d.	71 d
69	652	225
70	662	228
71	671	231
72	681	234
73	690	238
74	699	241
75	709	244
76	718	247
77	728	251
78	737	254
79	747	257
80	756	261
81	766	264
82	775	267
83	785	270
84	794	274
85	804	277
86	813	280
87	822	283
88	832	287
89	841	290
90	851	293
91	860	296
92	870	300
93	879	303
94	889	306
95	898	309
96	908	313
97	917	316
98	926	319
99	936	322
100	945	326
200	1891	651
300	2830	977

M	20d	70 d.	M	20d	70d	Min.	20 d.	70 d.
1	9	3	35	329	120	69	648	236
2	19	7	36	338	123	70	658	239
3	28	10	37	348	126	71	667	243
4	38	14	38	357	130	72	677	246
5	47	17	39	366	133	73	686	250
6	56	20	40	376	137	74	695	253
7	66	24	41	385	140	75	705	256
8	75	27	42	395	144	76	714	260
9	85	31	43	404	147	77	724	263
10	94	34	44	413	150	78	733	267
11	103	38	45	423	154	79	742	270
12	113	41	46	432	157	80	752	274
13	122	44	47	442	161	81	761	277
14	132	48	48	451	164	82	771	280
15	141	51	49	460	168	83	780	284
16	150	55	50	470	171	84	789	287
17	160	58	51	479	174	85	800	291
18	169	61	52	489	178	86	808	294
19	179	65	53	498	181	87	818	298
20	188	68	54	507	185	88	827	301
21	197	72	55	517	188	89	836	304
22	207	75	56	526	191	90	846	308
23	216	79	57	536	195	91	855	311
24	226	82	58	545	198	92	864	315
25	235	85	59	554	202	93	874	318
26	244	89	60	564	205	94	883	321
27	254	92	61	573	209	95	893	325
28	263	96	62	583	212	96	902	328
29	272	100	63	592	215	97	912	332
30	282	103	64	601	219	98	921	335
31	291	106	65	611	222	99	930	339
32	301	109	66	620	226	100	940	342
33	310	113	67	630	229	200	1879	684
34	319	116	68	639	233	300	2819	1026

M	21d	69 d.
1	9	4
2	19	7
3	28	11
4	37	14
5	47	18
6	56	21
7	65	25
8	75	29
9	84	32
10	93	36
11	103	39
12	112	43
13	121	47
14	131	50
15	140	54
16	149	57
17	159	61
18	168	64
19	177	68
20	187	72
21	196	75
22	205	79
23	215	82
24	224	86
25	233	90
26	243	93
27	252	97
28	261	100
29	271	104
30	280	107
31	289	111
32	299	115
33	308	118
34	317	122

M	21d	69d
35	327	125
36	336	129
37	345	132
38	355	136
39	364	140
40	373	143
41	383	147
42	392	150
43	401	154
44	411	158
45	420	161
46	429	165
47	439	168
48	448	172
49	457	176
50	467	179
51	476	183
52	485	186
53	495	190
54	504	193
55	513	197
56	523	201
57	532	204
58	541	208
59	551	211
60	560	215
61	569	219
62	579	222
63	588	226
64	598	229
65	607	233
66	616	236
67	626	240
68	635	244

Min.	21 d.	69 d.
69	644	247
70	653	251
71	663	254
72	672	258
73	681	262
74	691	265
75	700	269
76	709	272
77	719	276
78	728	279
79	737	283
80	747	287
81	756	290
82	766	294
83	775	297
84	784	301
85	794	305
86	803	308
87	812	312
88	822	315
89	831	319
90	840	323
91	849	326
92	859	330
93	868	333
94	877	337
95	887	340
96	896	344
97	905	348
98	915	351
99	924	355
100	934	358
200	1867	717
300	2801	1075

M	22d	68d	M	22d	68d	Min.	22 d.	68 d.
1	9	4	35	324	131	69	640	259
2	19	7	36	334	135	70	649	262
3	28	11	37	343	139	71	658	266
4	37	15	38	352	142	72	667	270
5	46	19	39	361	146	73	677	274
6	56	22	40	371	150	74	686	277
7	65	26	41	380	154	75	695	281
8	74	30	42	389	157	76	705	285
9	83	34	43	399	161	77	714	289
10	93	37	44	408	165	78	723	293
11	102	41	45	417	169	79	733	296
12	111	45	46	426	172	80	742	300
13	120	49	47	436	176	81	751	304
14	130	52	48	445	180	82	760	307
15	139	56	49	454	184	83	770	311
16	148	60	50	464	187	84	779	315
17	157	64	51	473	191	85	788	319
18	167	67	52	482	195	86	797	322
19	176	71	53	491	199	87	806	326
20	185	75	54	501	202	88	816	330
21	195	79	55	510	206	89	825	334
22	204	82	56	519	210	90	834	337
23	213	86	57	529	214	91	844	341
24	222	90	58	538	217	92	853	345
25	232	94	59	547	221	93	862	449
26	241	97	60	556	225	94	871	352
27	250	101	61	566	229	95	881	356
28	260	105	62	575	232	96	890	360
29	269	109	63	584	236	97	899	364
30	278	112	64	594	240	98	909	367
31	287	116	65	603	244	99	918	371
32	297	120	66	612	247	100	927	375
33	306	124	67	621	251	200	1854	749
34	315	127	68	631	255	300	2782	1094

M	23d	67 d.
1	9	4
2	18	8
3	28	12
4	37	16
5	46	19
6	55	23
7	64	27
8	74	31
9	83	35
10	92	39
11	101	43
12	110	47
13	120	51
14	129	55
15	138	59
16	147	62
17	156	66
18	166	70
19	175	74
20	184	78
21	193	82
22	202	86
23	212	90
24	221	94
25	230	98
26	239	102
27	248	105
28	258	109
29	267	113
30	276	117
31	285	121
32	294	125
33	304	129
34	313	133
35	322	137
36	331	141
37	340	144
38	350	148
39	359	152
40	368	156
41	377	160
42	386	164
43	396	168
44	405	172
45	414	176
46	423	180
47	433	184
48	442	187
49	451	191
50	460	195
51	469	199
52	479	203
53	488	207
54	497	211
55	506	215
56	515	219
57	524	223
58	534	226
59	543	230
60	552	234
61	561	238
62	571	242
63	580	246
64	589	250
65	598	254
66	608	258
67	618	262
68	626	266

Min.	23 d.	67 d.
69	635	269
70	644	273
71	653	277
72	663	281
73	672	285
74	681	289
75	690	293
76	699	297
77	709	301
78	718	305
79	727	308
80	736	312
81	746	316
82	755	320
83	764	324
84	773	328
85	782	332
86	792	336
87	801	340
88	810	344
89	819	348
90	828	352
91	838	356
92	847	360
93	856	363
94	865	367
95	874	370
96	884	375
97	893	379
98	902	383
99	911	387
100	920	391
200	1841	781
300	2761	1172

M	24d	66d	M	24d	66d	Min.	24 d.	66 d.
1	9	4	35	320	142	69	630	281
2	18	8	36	329	146	70	639	285
3	27	12	37	338	151	71	648	289
4	36	16	38	347	155	72	658	293
5	46	20	39	356	159	73	667	297
6	55	24	40	365	163	74	676	301
7	64	28	41	374	167	75	685	305
8	73	32	42	384	171	76	694	309
9	82	37	43	393	175	77	703	313
10	91	41	44	402	179	78	712	317
11	100	45	45	411	183	79	721	321
12	109	49	46	420	187	80	731	325
13	119	53	47	429	191	81	740	329
14	128	57	48	438	195	82	749	333
15	137	61	49	448	199	83	758	337
16	146	65	50	457	203	84	767	341
17	155	69	51	466	207	85	776	345
18	164	73	52	475	211	86	785	349
19	173	77	53	484	216	87	795	353
20	183	81	54	493	220	88	804	357
21	192	85	55	502	224	89	813	362
22	201	90	56	511	228	90	822	366
23	210	94	57	521	232	91	831	370
24	219	98	58	530	236	92	840	374
25	228	102	59	539	240	93	849	378
26	237	106	60	548	244	94	858	382
27	246	110	61	557	248	95	868	386
28	256	113	62	566	252	96	877	390
29	265	117	63	575	256	97	886	393
30	274	122	64	585	260	98	895	399
31	283	126	65	594	264	99	904	403
32	292	130	66	603	268	100	913	407
33	301	134	67	612	272	200	1827	813
34	310	138	68	621	276	300	2740	1220

M	25d	65 d.
1	9	4
2	18	8
3	27	13
4	36	17
5	45	21
6	54	25
7	63	30
8	72	34
9	81	38
10	91	42
11	100	47
12	109	51
13	118	55
14	127	59
15	136	63
16	145	68
17	154	72
18	163	76
19	172	80
20	181	84
21	190	89
22	199	93
23	208	97
24	218	100
25	227	106
26	236	110
27	245	114
28	254	118
29	263	123
30	272	127
31	281	131
32	290	135
33	299	140
34	308	144

M	25d	65d
35	317	148
36	326	152
37	335	156
38	344	161
39	353	165
40	362	169
41	372	173
42	381	178
43	390	182
44	399	186
45	408	190
46	417	195
47	426	199
48	435	203
49	444	207
50	453	211
51	462	216
52	471	220
53	480	224
54	489	228
55	498	232
56	507	237
57	516	241
58	526	245
59	535	250
60	544	254
61	553	258
62	562	262
63	571	267
64	580	271
65	589	275
66	598	279
67	607	283
68	616	288

Min.	25 d.	65 d.
69	625	292
70	634	296
71	643	300
72	652	305
73	662	309
74	671	313
75	680	317
76	689	321
77	698	326
78	707	330
79	716	334
80	725	338
81	734	343
82	743	347
83	752	351
84	761	355
85	770	360
86	779	364
87	788	368
88	797	372
89	807	376
90	816	380
91	825	384
92	834	389
93	843	393
94	852	397
95	861	401
96	870	406
97	879	410
98	888	414
99	897	418
100	906	423
200	1813	845
300	2719	1268

M	26d	64 d
1	9	4
2	18	9
3	27	13
4	36	18
5	45	22
6	54	26
7	63	31
8	72	35
9	81	39
10	90	44
11	99	48
12	108	53
13	117	57
14	126	61
15	135	66
16	144	70
17	153	74
18	162	79
19	171	83
20	180	88
21	189	92
22	198	96
23	207	101
24	216	105
25	225	109
26	234	114
27	243	118
28	252	123
29	261	127
30	270	131
31	279	136
32	288	140
33	297	144
34	306	149
35	315	153
36	324	158
37	333	162
38	342	166
39	351	171
40	360	175
41	368	179
42	378	184
43	386	188
44	395	192
45	404	197
46	413	202
47	422	206
48	431	210
49	440	214
50	449	219
51	458	223
52	467	228
53	476	232
54	485	237
55	494	241
56	503	245
57	512	250
58	521	254
59	530	258
60	539	263
61	548	267
62	557	272
63	566	276
64	575	280
65	584	285
66	593	289
67	602	294
68	611	298

Min.	26d.	64 d.
69	620	302
70	629	307
71	638	311
72	647	316
73	656	320
74	665	324
75	674	329
76	683	333
77	692	338
78	701	342
79	710	346
80	719	351
81	728	355
82	737	359
83	746	364
84	755	368
85	764	372
86	773	377
87	782	381
88	791	385
89	800	390
90	809	394
91	818	399
92	827	403
93	836	407
94	845	412
95	854	416
96	863	421
97	872	425
98	881	429
99	890	434
100	899	438
200	1798	877
300	2696	1315

M	27 d	63 d.
1	9	5
2	18	9
3	27	14
4	36	18
5	45	23
6	53	27
7	62	32
8	71	36
9	80	41
10	89	45
11	98	50
12	107	54
13	116	59
14	125	63
15	134	68
16	143	72
17	151	77
18	160	82
19	169	86
20	178	91
21	187	95
22	196	100
23	205	104
24	214	109
25	223	113
26	232	118
27	241	122
28	249	127
29	258	132
50	267	136
31	276	141
32	285	145
33	294	150
34	303	154

M	27 d	63 d
35	312	159
36	321	163
37	330	168
38	338	172
39	347	177
40	356	182
41	365	187
42	374	191
43	383	195
44	391	200
45	401	204
46	410	209
47	429	213
48	428	218
49	436	222
50	445	228
51	454	232
52	463	236
53	472	241
54	481	245
55	490	250
56	499	254
57	508	259
58	517	263
59	526	268
60	535	272
61	543	277
62	552	282
63	561	286
64	570	291
65	579	295
66	588	300
67	597	304
68	606	309

Min.	27 d.	63 d.
69	615	313
70	624	318
71	633	322
72	641	327
73	650	332
74	659	336
75	668	341
76	677	345
77	686	350
78	695	354
79	704	359
80	713	363
81	722	368
82	731	372
83	739	377
84	748	381
85	757	386
86	766	390
87	775	395
88	784	400
89	793	404
90	802	409
91	811	413
92	820	418
93	829	422
94	837	427
95	846	431
96	855	436
97	864	440
98	873	445
99	882	449
100	891	454
200	1782	909
300	2673	1363

M	28d	62 d.	M	28d	62d	Min.	28 d.	62 d.
1	9	5	35	309	164	69	609	324
2	18	9	36	318	169	70	618	329
3	26	14	37	326	174	71	627	333
4	35	19	38	335	178	72	636	338
5	44	23	39	344	183	73	644	343
6	53	28	40	353	188	74	653	347
7	62	33	41	362	192	75	662	352
8	71	37	42	371	197	76	671	357
9	79	42	43	380	202	77	680	361
10	88	47	44	388	207	78	689	366
11	97	52	45	397	211	79	697	371
12	106	56	46	406	216	80	706	376
13	115	61	47	415	221	81	715	380
14	124	66	48	424	225	82	724	385
15	132	70	49	432	230	83	733	390
16	141	75	50	441	235	84	742	394
17	150	80	51	450	239	85	750	399
18	159	84	52	459	244	86	759	404
19	168	89	53	468	249	87	768	408
20	177	94	54	477	254	88	777	413
21	185	99	55	485	258	89	786	418
22	194	103	56	494	263	90	795	422
23	203	108	57	503	268	91	803	427
24	212	113	58	512	272	92	812	432
25	221	117	59	521	277	93	821	437
26	230	122	60	530	282	94	830	441
27	238	127	61	538	286	95	839	446
28	247	131	62	547	291	96	848	451
29	256	136	63	556	296	97	856	455
30	265	141	64	565	300	98	865	460
31	274	145	65	574	305	99	874	465
32	282	150	66	583	310	100	883	469
33	291	155	67	591	315	200	1766	939
34	300	160	68	600	319	300	2649	1408

M	29d	61 d.	M	29d	61d	Min.	29 d.	61 d.
1	9	5	35	306	170	69	604	334
2	17	10	36	315	174	70	612	339
3	26	14	37	324	179	71	621	344
4	35	19	38	332	184	72	630	349
5	44	24	39	341	189	73	638	354
6	52	29	40	350	194	74	647	359
7	61	34	41	359	199	75	656	363
8	70	39	42	367	203	76	665	368
9	79	43	43	376	208	77	673	373
10	87	48	44	385	213	78	682	378
11	96	53	45	394	218	79	691	383
12	105	58	46	402	223	80	700	388
13	114	63	47	411	228	81	708	393
14	122	68	48	420	233	82	717	397
15	131	73	49	429	237	83	726	402
16	140	77	50	437	242	84	735	407
17	149	82	51	446	247	85	743	412
18	157	87	52	455	252	86	752	417
19	166	92	53	464	257	87	761	422
20	175	97	54	472	262	88	770	427
21	184	102	55	481	267	89	778	431
22	192	107	56	490	271	90	787	436
23	201	111	57	499	276	91	796	441
24	210	116	58	507	281	92	805	446
25	219	121	59	516	286	93	813	451
26	227	126	60	525	291	94	822	456
27	236	131	61	534	296	95	831	461
28	245	136	62	542	301	96	840	465
29	254	141	63	551	305	97	848	470
30	262	145	64	560	310	98	857	475
31	271	150	65	569	315	99	866	480
32	280	155	66	577	320	100	875	485
33	289	160	67	586	325	200	1749	970
34	297	165	68	595	330	300	2624	1454

M	30d	60d	M	30d	60d	Min.	30d.	60d.
1	9	5	35	303	175	69	598	345
2	17	10	36	312	180	70	606	350
3	26	15	37	320	185	71	615	355
4	35	20	38	329	190	72	623	360
5	43	25	39	338	195	73	632	365
6	52	30	40	346	200	74	641	370
7	61	35	41	355	205	75	649	375
8	69	40	42	364	210	76	658	380
9	78	45	43	372	215	77	667	385
10	87	50	44	381	220	78	676	390
11	95	55	45	390	225	79	684	395
12	104	60	46	398	230	80	693	400
13	113	65	47	407	235	81	702	405
14	121	70	48	416	240	82	710	410
15	130	75	49	424	245	83	719	415
16	139	80	50	433	250	84	727	420
17	147	85	51	442	255	85	736	425
18	156	90	52	450	260	86	745	430
19	165	95	53	459	265	87	753	435
20	173	100	54	468	270	88	762	440
21	182	105	55	476	275	89	771	445
22	191	110	56	485	280	90	779	450
23	199	115	57	494	285	91	788	455
24	208	120	58	502	290	92	797	460
25	217	129	59	511	295	93	806	465
26	225	130	60	520	300	94	814	470
27	234	135	61	528	305	95	823	475
28	242	140	62	537	310	96	832	480
29	251	145	63	546	315	97	840	485
30	260	150	64	554	320	98	849	490
31	268	155	65	563	325	99	857	495
32	277	160	66	572	330	100	866	500
33	286	165	67	580	335	200	1732	1000
34	294	170	68	589	340	300	2598	1500

M	31d	59 d.	M	31d	59d	Min.	31 d.	59 d.
1	9	5	35	300	180	69	591	355
2	17	10	36	309	185	70	600	360
3	26	15	37	317	191	71	609	366
4	34	21	38	326	196	72	617	371
5	43	26	39	334	201	73	626	376
6	51	31	40	343	206	74	634	381
7	60	36	41	351	211	75	643	386
8	69	41	42	360	216	76	651	391
9	77	46	43	369	221	77	660	397
10	86	51	44	377	227	78	669	402
11	94	57	45	386	232	79	677	407
12	103	62	46	394	237	80	686	412
13	111	67	47	403	242	81	694	417
14	120	72	48	411	247	82	703	422
15	129	77	49	420	252	83	711	427
16	137	82	50	429	257	84	720	433
17	146	88	51	437	263	85	729	438
18	154	93	52	446	268	86	737	443
19	163	98	53	454	273	87	746	448
20	171	103	54	463	278	88	754	453
21	180	108	55	471	283	89	763	458
22	189	113	56	480	288	90	771	463
23	197	118	57	489	294	91	780	469
24	206	124	58	497	299	92	789	474
25	214	129	59	506	304	93	797	479
26	223	134	60	514	309	94	806	484
27	231	139	61	523	314	95	814	489
28	240	144	62	531	319	96	823	494
29	249	149	63	540	324	97	831	500
30	257	154	64	549	330	98	840	505
31	266	160	65	557	335	99	849	510
32	274	165	66	566	340	100	857	515
33	283	170	67	574	345	200	1714	1030
34	292	175	68	583	350	300	2572	1545

M	32d	58d	M	32d	58d	Min.	32 d.	58 d.
1	8	5	35	297	185	69	585	366
2	17	11	36	305	191	70	594	371
3	25	16	37	314	196	71	602	376
4	34	21	38	322	201	72	610	381
5	42	26	39	331	207	73	619	387
6	51	32	40	339	212	74	627	392
7	59	37	41	348	217	75	636	397
8	68	42	42	356	223	76	644	403
9	76	48	43	365	228	77	653	408
10	85	53	44	373	238	78	661	413
11	93	58	45	382	240	79	670	419
12	102	64	46	390	244	80	678	424
13	110	69	47	398	249	81	687	429
14	119	74	48	407	254	82	695	434
15	127	79	49	415	260	83	703	440
16	136	85	50	424	265	84	712	445
17	144	90	51	432	270	85	721	450
18	153	95	52	441	275	86	729	456
19	161	101	53	449	281	87	738	461
20	170	106	54	458	286	88	746	466
21	178	111	55	466	291	89	755	472
22	187	117	56	475	297	90	763	477
23	195	122	57	483	302	91	772	482
24	204	127	58	492	307	92	780	487
25	212	132	59	500	313	93	788	493
26	220	138	60	509	318	94	797	498
27	229	143	61	517	323	95	805	503
28	237	148	62	526	329	96	814	509
29	246	153	63	534	334	97	822	514
30	254	159	64	543	339	98	831	519
31	263	164	65	551	344	99	839	524
32	271	170	66	560	350	100	848	530
33	280	175	67	568	355	200	1696	1060
34	288	180	68	577	360	300	2544	1590

M	33d	57 d.	M	33d	57d	Min.	33 d.	57 d.
1	8	5	35	294	191	69	579	376
2	17	11	36	302	196	70	587	381
3	25	16	37	311	202	71	596	386
4	34	22	38	319	207	72	604	392
5	42	27	39	327	212	73	612	397
6	50	33	40	335	218	74	621	403
7	59	38	41	344	223	75	629	408
8	67	44	42	352	229	76	637	414
9	76	49	43	361	234	77	646	419
10	84	54	44	369	240	78	654	425
11	92	60	45	377	245	79	663	430
12	101	65	46	386	251	80	671	436
13	109	71	47	394	256	81	679	441
14	117	76	48	403	262	82	688	446
15	126	82	49	411	267	83	696	452
16	134	87	50	419	272	84	705	457
17	143	93	51	428	278	85	713	462
18	151	98	52	436	283	86	721	468
19	159	104	53	445	288	87	730	473
20	168	109	54	453	294	88	738	479
21	176	114	55	461	300	89	747	484
22	185	120	56	470	305	90	755	490
23	193	125	57	478	310	91	763	495
24	201	131	58	487	316	92	772	501
25	210	136	59	495	321	93	780	506
26	218	142	60	503	327	94	789	512
27	227	147	61	512	332	95	797	517
28	235	153	62	520	338	96	805	522
29	243	158	63	529	343	97	814	528
30	252	163	64	537	348	98	822	533
31	260	169	65	545	354	99	831	539
32	269	174	66	554	359	100	839	545
33	277	180	67	562	365	200	1677	1089
34	285	185	68	571	370	300	2516	1634

M	34d	56d.	M	34d	56d	Min.	34 d.	56 d.
1	8	6	35	290	196	69	572	386
2	17	11	36	298	201	70	580	391
3	25	17	37	307	207	71	588	397
4	33	22	38	315	212	72	597	403
5	41	28	39	323	218	73	605	408
6	50	34	40	332	224	74	613	414
7	58	39	41	340	229	75	622	419
8	66	45	42	348	235	76	630	425
9	75	50	43	356	240	77	638	431
10	83	56	44	365	246	78	647	436
11	91	61	45	373	251	79	655	442
12	99	67	46	381	257	80	663	447
13	108	73	47	390	263	81	671	453
14	116	78	48	398	268	82	680	458
15	124	84	49	406	274	83	688	464
16	133	89	50	414	280	84	696	470
17	141	95	51	423	285	85	705	475
18	149	101	52	431	291	86	713	481
19	158	106	53	439	296	87	721	486
20	166	112	54	448	302	88	729	492
21	174	117	55	456	307	89	738	498
22	182	123	56	464	313	90	746	503
23	191	129	57	473	319	91	754	509
24	199	134	58	481	324	92	763	514
25	207	140	59	489	330	93	771	520
26	216	145	60	497	335	94	779	526
27	224	151	61	506	341	95	788	531
28	232	157	62	514	346	96	796	537
29	240	162	63	522	352	97	804	542
30	249	168	64	530	358	98	812	548
31	257	173	65	539	363	99	821	554
32	265	179	66	547	369	100	829	559
33	274	184	67	555	374	200	1658	1118
34	282	190	68	564	380	300	2487	1678

M	35 d	55 d.
1	8	6
2	17	11
3	25	17
4	33	23
5	41	29
6	49	34
7	57	40
8	66	46
9	74	52
10	82	57
11	90	63
12	98	69
13	106	75
14	115	80
15	123	86
16	131	92
17	139	98
18	147	103
19	156	109
20	164	115
21	172	120
22	180	126
23	188	132
24	196	138
25	205	143
26	213	149
27	221	155
28	229	161
29	237	166
30	246	172
31	254	178
32	262	184
33	270	189
34	278	195

M	35 d	55 d
35	286	201
36	295	206
37	303	212
38	311	218
39	319	224
40	328	229
41	336	235
42	344	241
43	352	246
44	360	252
45	368	258
46	377	264
47	385	270
48	393	275
49	401	281
50	410	287
51	418	292
52	426	298
53	434	304
54	442	310
55	451	315
56	459	321
57	467	327
58	475	333
59	483	338
60	491	344
61	500	350
62	508	356
63	516	361
64	524	367
65	533	373
66	541	379
67	549	384
68	557	390

Min.	35 d.	55 d.
69	565	396
70	573	402
71	582	407
72	590	413
73	598	419
74	606	425
75	615	430
76	623	436
77	631	442
78	639	448
79	647	453
80	655	459
81	664	465
82	672	470
83	680	476
84	688	482
85	696	488
86	705	493
87	713	499
88	721	505
89	729	511
90	737	516
91	746	522
92	754	528
93	762	534
94	770	539
95	778	545
96	786	551
97	795	556
98	803	562
99	811	568
100	819	574
200	1638	1147
300	2458	1721

M	36d	54 d.	M	36d	54d	Min.	36 d.	54 d.
1	8	6	35	283	206	69	558	406
2	16	12	36	291	211	70	566	411
3	24	18	37	299	217	71	574	417
4	32	23	38	307	223	72	582	423
5	40	29	39	315	229	73	590	429
6	48	35	40	324	235	74	599	435
7	57	41	41	332	241	75	607	441
8	65	47	42	340	247	76	615	447
9	72	53	43	348	253	77	623	453
10	81	59	44	356	258	78	631	458
11	89	65	45	364	264	79	639	464
12	97	70	46	372	270	80	647	470
13	105	76	47	380	276	81	655	476
14	113	82	48	388	282	82	663	488
15	121	88	49	396	288	83	671	492
16	129	94	50	404	294	84	680	494
17	138	100	51	413	300	85	688	500
18	146	106	52	421	306	86	696	506
19	154	112	53	429	311	87	704	511
20	162	118	54	437	317	88	712	517
21	170	123	55	445	323	89	720	523
22	178	129	56	453	329	90	728	529
23	186	135	57	461	335	91	736	535
24	194	141	58	469	341	92	744	541
25	202	147	59	477	347	93	752	547
26	210	153	60	485	353	94	760	553
27	218	159	61	493	358	95	768	558
28	226	164	62	502	364	96	777	564
29	235	170	63	510	370	97	785	570
30	243	176	64	518	376	98	793	576
31	251	182	65	526	382	99	801	582
32	259	188	66	534	388	100	809	588
33	267	194	67	542	394	200	1618	1176
34	275	200	68	550	400	300	2427	1763

M	37d	53 d.	M	37d	53d	Min.	37 d.	53 d.
1	8	6	35	279	210	69	551	415
2	16	12	36	287	216	70	559	421
3	24	18	37	295	222	71	567	427
4	32	24	38	303	228	72	575	433
5	40	30	39	311	234	73	583	439
6	48	36	40	319	241	74	591	445
7	56	42	41	327	247	75	599	451
8	64	48	42	335	253	76	607	457
9	72	54	43	343	259	77	615	463
10	80	60	44	351	265	78	623	469
11	88	66	45	359	271	79	631	475
12	96	72	46	367	277	80	639	481
13	104	78	47	375	283	81	647	487
14	112	84	48	383	289	82	655	493
15	120	90	49	391	295	83	663	500
16	128	96	50	399	301	84	671	506
17	136	102	51	407	307	85	679	512
18	144	108	52	415	313	86	687	518
19	152	114	53	423	319	87	695	524
20	160	120	54	431	325	88	703	530
21	168	126	55	439	331	89	711	536
22	176	132	56	447	337	90	719	542
23	184	138	57	455	343	91	727	548
24	192	144	58	463	349	92	735	554
25	200	150	59	471	355	93	743	560
26	208	156	60	479	361	94	751	566
27	216	162	61	487	367	95	759	572
28	224	168	62	495	373	96	767	578
29	232	174	63	503	379	97	775	584
30	240	180	64	511	385	98	783	590
31	248	186	65	519	391	99	791	596
32	256	192	66	527	397	100	799	602
33	264	198	67	535	403	200	1597	1204
34	271	204	68	543	409	300	2396	1805

M	38 d	52 d.	M	38 d	52 d	Min.	38 d.	52 d
1	8	6	35	276	216	69	544	425
2	16	12	36	284	222	70	552	431
3	24	18	37	292	228	71	559	437
4	31	25	38	299	234	72	567	443
5	39	31	39	307	240	73	575	450
6	47	37	40	315	246	74	583	456
7	55	43	41	323	252	75	591	462
8	63	49	42	331	259	76	599	468
9	71	55	43	339	265	77	607	474
10	79	62	44	347	271	78	615	480
11	87	68	45	355	277	79	622	486
12	95	74	46	362	283	80	630	493
13	102	80	47	370	289	81	638	499
14	110	86	48	378	295	82	646	505
15	118	92	49	386	302	83	654	511
16	126	99	50	394	308	84	662	517
17	134	105	51	402	314	85	670	523
18	142	111	52	410	320	86	678	530
19	150	117	53	418	326	87	686	536
20	158	123	54	426	332	88	693	542
21	166	129	55	433	339	89	701	548
22	173	136	56	441	345	90	709	554
23	181	142	57	449	351	91	717	560
24	189	148	58	457	357	92	725	566
25	197	154	59	465	363	93	733	573
26	205	160	60	473	369	94	741	579
27	213	166	61	481	376	95	749	585
28	221	172	62	489	382	96	756	591
29	229	179	63	496	388	97	764	597
30	236	185	64	504	394	98	772	603
31	244	191	65	512	400	99	780	610
32	252	197	66	520	406	100	788	616
33	260	202	67	528	412	200	1576	1231
34	268	208	68	536	419	300	2364	1847

M	39d	51 d.
1	8	6
2	16	13
3	23	19
4	31	25
5	39	31
6	47	38
7	54	44
8	62	50
9	70	57
10	78	63
11	85	69
12	93	75
13	101	82
14	109	88
15	116	94
16	124	101
17	132	107
18	140	113
19	148	119
20	155	126
21	163	132
22	171	138
23	179	145
24	186	151
25	194	157
26	202	164
27	210	170
28	217	176
29	225	182
30	233	189
31	241	195
32	249	201
33	256	208
34	264	214

M	39d	51d
35	272	220
36	280	226
37	287	233
38	295	239
39	303	245
40	311	252
41	318	258
42	326	264
43	334	271
44	342	277
45	350	283
46	357	289
47	365	296
48	373	302
49	381	308
50	388	315
51	396	321
52	404	327
53	412	334
54	419	340
55	427	346
56	435	352
57	443	359
58	451	365
59	458	371
60	466	378
61	474	384
62	482	390
63	489	396
64	497	403
65	505	409
66	513	415
67	521	422
68	528	428

Min.	39 d.	51 d.
69	536	434
70	544	440
71	552	447
72	559	453
73	567	459
74	575	466
75	583	472
76	591	478
77	598	485
78	606	491
79	614	497
80	622	503
81	629	510
82	637	516
83	645	522
84	653	529
85	661	535
86	668	541
87	676	547
88	684	554
89	692	560
90	699	566
91	707	573
92	715	579
93	723	585
94	731	591
95	738	598
96	746	604
97	754	610
98	762	617
99	769	623
100	777	629
200	1554	1259
300	2331	1888

M	40d	50d	M	40d	50d	Min.	40 d.	50 d.
1	8	6	35	268	225	69	529	443
2	15	13	36	276	231	70	536	450
3	23	19	37	283	238	71	544	456
4	31	26	38	291	244	72	552	463
5	38	32	39	299	251	73	559	469
6	46	38	40	306	257	74	567	476
7	54	45	41	314	263	75	574	482
8	61	51	42	322	270	76	582	489
9	69	58	43	329	276	77	590	495
10	77	64	44	337	283	78	597	501
11	84	71	45	345	289	79	605	508
12	92	77	46	352	296	80	613	514
13	100	83	47	360	302	81	620	521
14	107	90	48	368	309	82	628	527
15	115	96	49	375	315	83	636	533
16	123	103	50	383	321	84	643	540
17	130	109	51	391	328	85	651	546
18	138	116	52	398	334	86	659	553
19	146	122	53	406	341	87	666	559
20	153	129	54	414	347	88	674	566
21	161	135	55	421	353	89	682	572
22	169	141	56	429	360	90	689	579
23	176	148	57	437	366	91	697	585
24	184	154	58	444	373	92	705	591
25	192	161	59	452	379	93	712	598
26	199	167	60	460	386	94	720	604
27	207	173	61	467	392	95	727	611
28	214	180	62	475	399	96	735	617
29	222	186	63	483	405	97	743	623
30	230	193	64	490	411	98	751	630
31	237	199	65	498	418	99	758	636
32	245	206	66	506	424	100	766	643
33	253	212	67	513	431	200	1532	1286
34	260	219	68	521	437	300	2298	1928

M	41 d	49 d.	M	41 d	49 d	Min.	41 d.	49 d.
1	8	7	35	264	229	69	521	452
2	15	13	36	272	236	70	528	459
3	23	20	37	279	243	71	536	466
4	30	26	38	287	249	72	543	472
5	38	33	39	294	256	73	551	478
6	45	39	40	302	262	74	558	485
7	53	46	41	309	269	75	566	492
8	60	52	42	317	275	76	574	498
9	68	59	43	324	282	77	581	505
10	75	66	44	332	289	78	589	512
11	83	72	45	339	295	79	596	518
12	91	79	46	347	302	80	604	525
13	98	85	47	354	308	81	611	531
14	106	92	48	362	315	82	619	538
15	113	98	49	369	321	83	626	544
16	121	105	50	377	328	84	634	551
17	128	112	51	385	334	85	641	557
18	136	118	52	392	341	86	649	564
19	143	125	53	400	348	87	656	571
20	151	131	54	407	354	88	664	577
21	159	138	55	415	361	89	671	584
22	166	144	56	422	367	90	679	590
23	174	151	57	430	374	91	687	597
24	181	157	58	438	380	92	694	603
25	189	164	59	445	387	93	702	610
26	196	171	60	453	394	94	709	616
27	204	177	61	460	400	95	717	623
28	211	184	62	468	407	96	724	629
29	219	190	63	475	413	97	732	636
30	226	197	64	483	420	98	739	643
31	234	203	65	490	426	99	747	649
32	241	210	66	498	433	100	755	656
33	249	216	67	506	439	200	1509	1312
34	257	223	68	513	446	300	2264	1968

M	42d	48d	M	42d	48d	Min.	42 d.	48 d.
1	7	7	35	260	234	69	513	462
2	15	13	36	267	241	70	520	468
3	22	20	37	275	247	71	527	475
4	30	27	38	282	254	72	535	482
5	37	33	39	290	261	73	542	488
6	44	40	40	297	268	74	550	495
7	53	47	41	304	274	75	557	502
8	59	53	42	312	281	76	564	509
9	67	60	43	419	287	77	572	515
10	74	67	44	327	294	78	579	522
11	82	73	45	334	301	79	587	529
12	89	80	46	342	308	80	594	535
13	97	87	47	349	314	81	602	542
14	104	93	48	357	321	82	609	549
15	111	100	49	364	328	83	617	555
16	119	107	50	372	335	84	624	562
17	126	113	51	379	341	85	632	569
18	134	120	52	386	348	86	639	575
19	141	127	53	394	354	87	647	582
20	140	134	54	401	361	88	654	589
21	156	140	55	409	368	89	661	595
22	163	147	56	416	375	90	669	602
23	171	154	57	423	381	91	676	609
24	178	160	58	431	388	92	684	615
25	186	167	59	438	394	93	691	622
26	193	174	60	446	401	94	699	629
27	201	180	61	453	408	95	706	635
28	208	187	62	461	415	96	713	642
29	215	194	63	468	421	97	721	649
30	223	201	64	475	428	98	728	655
31	230	207	65	483	435	99	736	662
32	238	214	66	490	442	100	743	669
33	245	221	67	498	448	200	1486	1338
34	253	227	68	505	455	300	2229	2007

M	43d	47 d.
1	7	7
2	15	14
3	22	20
4	29	27
5	36	34
6	44	41
7	51	48
8	58	54
9	65	61
10	73	68
11	80	75
12	88	82
13	95	89
14	102	95
15	110	102
16	117	109
17	124	116
18	132	123
19	139	130
20	146	136
21	153	143
22	161	150
23	168	157
24	175	164
25	183	170
26	190	177
27	197	184
28	205	191
29	212	198
30	219	205
31	227	211
32	234	218
33	241	225
34	248	232

M	43d	47d
35	256	239
36	263	245
37	270	252
38	278	259
39	285	266
40	292	273
41	300	280
42	307	286
43	314	293
44	322	300
45	329	307
46	330	314
47	344	320
48	351	327
49	358	334
50	366	341
51	373	348
52	380	355
53	388	361
54	395	368
55	402	375
56	409	382
57	417	389
58	424	395
59	431	402
60	439	409
61	446	416
62	453	423
63	461	430
64	468	436
65	475	443
66	483	450
67	490	457
68	497	464

Min.	43 d.	47 d.
69	505	470
70	512	477
71	519	484
72	526	491
73	534	498
74	541	505
75	548	511
76	556	518
77	563	525
78	570	532
79	578	539
80	585	546
81	592	552
82	600	559
83	607	566
84	614	573
85	622	580
86	629	587
87	636	593
88	643	600
89	651	607
90	658	614
91	665	621
92	673	627
93	680	634
94	687	641
95	695	648
96	702	655
97	709	661
98	717	668
99	724	675
100	731	682
200	1463	1364
300	2194	2046

M	44d	46 d.	M	44d	46d	Min.	44 d.	46 d
1	7	7	35	257	243	69	496	479
2	14	14	36	259	250	70	503	486
3	22	21	37	266	257	71	511	493
4	29	28	38	273	264	72	518	500
5	36	35	39	280	271	73	525	507
6	43	42	40	288	278	74	532	514
7	50	49	41	295	285	75	539	521
8	58	56	42	302	292	76	547	528
9	65	62	43	309	299	77	554	535
10	72	69	44	316	306	78	561	542
11	79	76	45	324	313	79	568	549
12	86	83	46	331	320	80	575	556
13	93	90	47	338	327	81	583	563
14	101	97	48	345	334	82	590	570
15	108	104	49	352	340	83	597	577
16	115	111	50	360	347	84	604	584
17	122	118	51	367	354	85	611	590
18	129	125	52	374	361	86	619	597
19	137	132	53	381	368	87	626	604
20	144	139	54	388	375	88	633	611
21	151	146	55	396	382	89	640	618
22	158	153	56	403	389	90	647	625
23	165	160	57	410	396	91	655	632
24	173	167	58	417	403	92	662	639
25	180	174	59	424	410	93	669	646
26	187	181	60	432	417	94	676	653
27	194	188	61	439	424	95	683	660
28	201	195	62	446	431	96	690	667
29	209	201	63	453	438	97	698	674
30	216	208	64	460	445	98	705	681
31	223	215	65	468	452	99	712	688
32	230	222	66	475	458	100	719	695
33	237	229	67	482	465	200	1439	1389
34	245	236	68	489	472	300	2158	2084

M	45d	51 d.
1	7	7
2	14	14
3	21	21
4	28	28
5	35	35
6	42	42
7	49	49
8	56	56
9	64	64
10	71	71
11	78	78
12	85	85
13	92	92
14	99	99
15	106	106
16	113	113
17	120	120
18	127	127
19	134	134
20	141	141
21	148	148
22	155	155
23	163	163
24	170	170
25	177	177
26	184	184
27	191	191
28	198	198
29	205	205
30	212	212
31	219	219
32	226	226
33	233	233
34	240	240

M	45d	45d
35	247	247
36	254	254
37	261	261
38	268	268
39	275	275
40	283	283
41	290	290
42	297	297
43	304	304
44	311	311
45	318	318
46	325	325
47	332	332
48	339	339
49	346	346
50	353	353
51	360	360
52	367	367
53	375	375
54	382	382
55	389	389
56	396	396
57	403	403
58	410	410
59	417	417
60	424	424
61	431	431
62	438	438
63	445	445
64	452	452
65	459	459
66	466	466
67	474	474
68	481	481

Min.	45 d.	45 d.
69	488	488
70	495	495
71	502	502
72	509	509
73	516	516
74	523	523
75	530	530
76	537	537
77	544	544
78	551	551
79	558	558
80	566	566
81	573	573
82	580	580
83	587	587
84	594	594
85	601	601
86	608	608
87	615	615
88	622	622
89	629	629
90	636	636
91	643	643
92	650	650
93	657	657
94	665	665
95	672	672
96	678	678
97	685	686
98	693	693
99	700	700
100	707	707
200	1414	1414
300	2121	2121

Now for the form of ſetting down a Reckoning, although he which is accuſtomed to keep it in this manner, may haply by uſe and practice diſcern how to order it in a better way then I can preſently preſcribe or think upon, becauſe he hath occaſion often to conſider it in every particular: yet in the mean time I conceive it will be fit to have a Book in *Folio*, that is, two Leaves to a ſheet of paper, and to keep the left ſide of your Book void, that you may write therein all ſuch Occurrents as you ſhall think requiſite. As namely, the Winds, and the Points of the *Compaſſe*, upon which your ſhip lies, and what allowance you make for *Lee-ward*-way when you ſail by winde, the number of Glaſſes or Hours, and how many Knots or Miles in each hour, alſo the Latitudes which you finde by obſervation of the *Meridian*-altitude of the Stars, and what elſe you ſhall think remarkable. But before all this, the title of the Voyage in theſe or like words.

The Journal of our Voyage intended by Gods aſſiſtance from S. I. *in the latitude of* 32 *deg.* 25 *min. to the Coaſt of* England, &c.

The right hand Pages, or the right ſide of your Book throughout, may by lines be divided into 12 Columns, as in the Example following doth appear. In the firſt Column may be expreſſed the *day*, in the ſecond *moneth*; or at leaſt once in the top of the page; likewiſe in the ſame ſecond column, being large enough, may be ſet down the *Latitudes* which you finde by the *Meridian altitudes* of the Sunne at ſuch times as you make obſervation. In the third col. the courſe (the *Lee-ward way*, if there be any leeing allowed.) In the 4. the *Variation of the Needle*. In the 5. (having made allowance for the *Variation*) ſet down the angle of your *Rumb* with the *Meridian*. In the 6. col. ſet down the *diſtance* in miles run upon that *Rumb*. In the 7, 8, 9, and 10 col. the *Northing*, or *Southing*, *Eaſting*, or *Weſting*, thereto anſwering, as you ſhall finde it by your *Table* In the 11. your *Latitudes* by dead reckoning. And laſtly, in the 12 column you may at ſuch times as you think fitteſt, ſet down your *Longitude* from the place from which you firſt departed, or the difference of Longitude from place to place.

da	Lat. by observation.	course	Variation.	Deg. fr. the mer.	dist. in miles.	North.	South.	East	West	Lat. by dead R	Longitude.
20	February	N E. by E.	8deg. west	ne 48d	miles 78	522		579		33.17	
21	Latitude 34d. 25′	N E. by E.	8deg. west	ne 48d	100	669		743		34.24	
	34d. 25′				Summe is	1191		1322		34.24	02.38
22		e n e ½ no.	8deg. west	ne 54d	100 56	588 329		809 453		35.56	
23	Latitude 37d. 46′	e n e ½ no.	8deg. west	ne 54d	100 78	588 458		809 631		37.40	
24	Latitude 39d. 36′	e n e ½ no.	8deg. west	ne 54d	100 84	588 494		809 679		39.28	
					Summe is	3045		4190			
					The correction by observ. is	80		1110		08	
24	l. 39. 30					3125		4300		39.36	11.36
25	February	e n e	8deg. west	ne 59½	100 76	507 385		861 655		41.05	
26		e n e	8deg. west	ne 59½	100 80	567 412		861 686		42.37	
27	Latitude 43d. 55′	e n e	7½de. west	ne 60d	100 84	500 420		866 728		44.09	
					Summe is	2731		4657	245		
					Correction			140		14	
27	L. 43. 55					2591		4412		43.55	21.28
28	February	e n e ½ e	6deg. west	ne 67d	100 51	391 199		921 469		44.54	
29		e n e ½ e	5deg. west	ne 68d	100 81	375 304		927 751		46.02	
1	March	e n e ½ e	4deg. west	ne 69d	100 66	358 237		934 616		47.02	
2	La. 48. 4	e n e ½ e	2deg. west	ne 71d	100 78	326 254		946 737		48.00	
2	Lat. 48. 4				Summe is	2444		6301		48.00	36.38

da.	Lat. by observation.	court.	Variation	Deg. from the Mer.	di. in miles	North.	South.	East	West	Lat. by dead R.	Longitude.
3	March	e n e	0 de.	ne 73d	100	292		956		48.44	
		½ e	west		52	152		497			
4		e n e	2 de.	ne 75d	100	259		966		49.28	
		½ e	East		68	176		657			
5	Latitude	e n e	3 de.	ne 76d	98	237		951		49.52	
	49d. 58′	½ e	East								
5	la. 49. 58			Summe is		1116		4027		49.52	46.52
5	8 Hours	nbye ½ e	4 de. East	ne 21d	18	168		64		50.09	
6		south by e.	4 de. East	s e 7 d.	34		337	41		49.35	
6	16 Hour	n by east	4 de. East.	ne 15d	36	348		93		50.10	
7		se by east	4 de. East	s e 52d	20		123	158		49.58	
8	Latitude 50 d. 4′	East.	4 de. East	se 86d	96		67	958		49.51	
	The current setting by Rima.	East nort. east.		ne 67½	60	230		554		50.14	
				Summe is		219		1868			
				Correction			100			10	
8	l. 50d 4′					119		1868		50.04	51.43
9		east ½ po. n	6 de. East	s e 89½ d	70		60	700		49.58	
10		east ½ po. n	6 de. East	s e 89½ d	52		41	520		49.54	
10	March			Summe is		1101		1220		49.54	54.53
	Here the Lizard bears	N by E			13						

For an example, we may frame a reckoning between the two places before-mentioned, namely from *Summer-Iſlands* to the *Lizard*, whoſe diſtance in their Rumb we have before ſuppoſed to be 3299 miles, as ſome Charts make it, and conſequently their difference of Longitude 70 deg. I would not be underſtood as if I affirmed it to be ſo much, for I ſuppoſe it is leſſe, I was there indeed about 20 years paſt, and ſurveyed it, and then kept a reckoning both outwards and homewards, but I have loſt thoſe reckonings long ſince, and have forgotten what they were, and in this caſe it matters not, for whether the ſuppoſition be neer the truth or not, it ſerves ſufficiently to exemplifie the rule, that being the end for which it is uſed. But if their diſtance be 3299 ſuch miles as contain onely 1000 paces in a mile, the ſame being reckoned in ſuch miles, as we have before-mentioned, namely, in ſuch whereof 60 make a degree of a great Circle, which as we find contain 6120 feet in a mile; their diſtance will be little more then 2695 miles; and conſequently, the difference of Longitude little more then 55 $\frac{1}{2}$ degrees.

Let us therefore ſuppoſe the difference of Longitude between thoſe two places to be 55 degrees, and their Latitudes to be the ſame as before, namely, of the one 32 deg. 25 min. and of the other 50 degrees. And let the Courſes, Diſtances, and other obſervations from *Summer-Iſlands* to the *Lizard* be ſuch as before is ſhewed.

This firſt entrance in this Journal (which is the 20 day of *February*) is thus to be underſtood; namely, that from the time of ſetting ſail (which we ſuppoſe to be the 19 of *February*) till the 20 day at noon, the Ship lies away, and makes her way good upon the Northeaſt and by E. point of the Compaſſe; but the Variation being 8 deg. to the Weſtwards (as in the fourth column appears) the rumb upon which ſhe hath run is from the North to the Eaſtwards onely 48d. as is expreſſed in the 5 column (it is indeed 48 $\frac{1}{4}$ deg. but the $\frac{1}{4}$ deg. we omit, as for the other circumſtances not to be regarded) upon this rumb ſhe runs 78 miles, as in the 6 column appears, and anſwerable thereto I find in the table before-going, the Northing to be 52 $\frac{3}{10}$ miles, and the Eaſting 57 $\frac{2}{10}$, as here in the ſeventh and ninth column is expreſt

by

by theſe numbers 522 and 579 (for the firſt figure towards the right hand ſignifieth the tenth parts of a mile, the reſt miles.) Hence then the Northing being 52 miles, if that be added to the Latitude from which it is reckoned, namely 32 deg. 25 min. it makes the Latitude here to be 33 deg. 17 min. as in the 11 Column appears. In like ſort, the ſecond entrance being the 21 of *February*, ſheweth that from the 20 day at noon to the 21, ſhe made her way good upon Northeaſt and by Eaſt point of the Compaſſe, but the Variation being 8 deg. Weſterly, the angle of the Rumb with the true Meridian was from the North to the Eaſtwards 48 deg. and ſo ſailing 100 miles, the Northing is $69\frac{2}{10}$ miles, and the Eaſting $74\frac{3}{10}$ miles, ſo that the Latitude now is 34 deg. 24 min. and the like is to be underſtood of all the reſt.

Touching the Longitude expreſſed in the laſt column, although a reckoning may be kept and ſet down without it, yet it is of very good uſe, and how to convert the Eaſting or Weſting (that is, the miles expreſſed in the Eaſt and Weſt columns of your Journal) into deg. and min. of Longitude; we will ſhew afterwards, as alſo how you may eaſily correct your courſe, and give the true courſe or Rumb, allowing the Variation.

But firſt to proceed with this Journal, obſerving the *Meridian* altitude of the Sun upon the 23 and 24 of *February*, I find that my Latitude upon the 24 is 39 deg. 36 min. whereas by dead reckoning it is but 39 deg. 28 min. ſo the difference is 8 more Northerly: but being well aſſured of the Latitude found by Obſervation, I correct the dead reckoning thereby, which may be done by the Rule of Proportion, ſaying;

As the Summe of the North column	3125	*Co.ar.* 6.50515
To the ſumme of the Eaſt column,	4300	3.63347
So the foreſaid increaſe Northerly	80	1.90309
To the increaſe Eaſterly	110	2.04171

that is, 11 miles: for the firſt place towards the right hand is only for the tenth parts of a mile.

The ſame may alſo ſufficiently be found without the Rule of Proportion, by the foregoing *Table*, onely for looking there under the Degree upon which I have ſailed, namely, under 54 deg.

deg. for 8 miles or 80 tenths of a mile, though I find not the ſame exactly, yet I finde one which is neer it, namely 82, and againſt it in the next collateral column 113, which is 11 $\frac{1}{10}$ miles (being too much by $\frac{3}{10}$ of a mile, becauſe the other is too much by $\frac{2}{10}$) I adde therefore in the North column of the Journal 8 miles, and the Eaſt column 11 miles; And ſo whereas by dead reckoning, the Northing was but 304 $\frac{5}{10}$ miles, and the Eaſting 419 miles; now having corrected it by obſervation, the Northing is 312 $\frac{1}{10}$ miles, and Eaſting 430 miles.

In like ſort upon the 27 day, I ſhould by dead reckoning be in the Latitude of 44 deg. 09 min. but by a clear and good obſervation I find my ſelf in the Latitude of 43 deg. 55 min. that is, not ſo much Northerly by 14 min. therefore to correct it I put in the South column 14 miles, or 140 tenths, and ſeeing my courſe was between the North and the Eaſt, and that I find my ſelf to be leſs to the Northwards, that is, more to the Southwards then my reckoning, therefore in probability I am alſo to the Eaſtwards, that is, more to the Weſtwards, then my reckoning; But to find how much, I look in the foregoing Table for the degree upon which I have ſailed, being from the North part of the Meridian to the Eaſtwards 60 deg. and under 60 deg. I look for 14 miles, or 140 tenths, and againſt it in the column adjoyning I find 243, which I ſet down in my Journal in the Weſt column, and ſo ſubſtracting the firſt from the North column, the other from the Eaſt: I finde that whereas by dead Reckoning I ſhould be to the Northwards 273 $\frac{1}{10}$ miles, and to the Eaſtwards 465 $\frac{7}{10}$. Now having corrected it by obſervation, I find that from the 24 day till this time I have run more Northerly then I was by 259 miles, and one tenth part, and more Eaſterly by 441 $\frac{2}{10}$ miles.

But if your courſe be neer the Eaſt or Weſt, it may ſuffice to correct it in Latitude onely, as in the example of the 8 of *March* appears; for in that caſe you cannot correct the Longitude, but from ſome further ground.

If there be any Current, you may note it as is done in that Example following the 8 of *March*.

Now if you would ſet down this reckoning upon the Plain or Common *Sea-chart*: Firſt, if you deſire to expreſſe every dayes

dayes account, you may begin for the 20 of *February*, and make a prick in your plat that may be from the place from which you ſet ſail to the Northwards 52 $\frac{3}{10}$ miles, and to the Eaſtwards 57 $\frac{9}{10}$; and ſo will this point be diſtant from the place of your ſetting ſail 78 miles Northeaſt, and almoſt a quarter of a point Eaſterly: then for the 21 day you may make another Prick, which may be from the form to the Northwards 66 $\frac{2}{10}$ miles, and to the Eaſtwards 74 $\frac{3}{10}$ miles, and ſo you may procced with the reſt. And thus you ſhall have a prick on the Plot for every day more exactly ſet down, then could be done after the ordinary way by Courſe and Diſtance, or Courſe and Latitude, eſpecially becauſe in lining the Plot, there are not, nor cannot conveniently be drawn any more then the 32 points of the *Compaſſe*, to wit, not half points, quarters, or ſingle *D*egrees.

But if you deſire not to ſet down every days reckoning (which is not neceſſary to be done) you may ſet down every of the Summes, as they are corrected by Obſervation after the ſelf-ſame manner.

Or you may adde together all thoſe ſummes, and ſo the ſumme total of the North column will be 1049 miles, and of the Eaſt column 2345 miles, therefore in the meridian of the place from which you depart, you may ſet down to the Northwards of that place 1049 miles, which will fall in the Latitude of 49 deg. 54 min. almoſt, and from thence in that parallel ſet down directly to the Eaſtwrds 2345 miles, and there make a prick for the place where the Ship then is the tenth of *March*, and ſo is all this reckoning ſet down at once.

If you keep reckoning according to *Mercator*, it will be requiſite ſometimes to ſum up your reckonings paſt, namely, ſo often as you make any notable alteration in your courſe; and ſo this reckoning or any other may be ſet down almoſt as eaſily on *Mercators chart*, the difference is, that here you muſt often alter your *Scale*, becauſe the deg. of Latitude on this *Chart* are not equal, but grow greater and greater towards the Poles. Now then the diſtance of two places is to be meaſured by that part of the *Meridian*, which is intercepted between the Latitudes of thoſe

two

two places; Or if both places lie in one and the ſame Latitude, their Diſtance is meaſured by a Degree or other leſſe quantity, taken about that Latitude; namely, half above, and half beneath.

Wherefore if you would make a Prick or Traverſe-point in *Mercators-chart*, anſwering to your reckoning for the firſt day, namely, untill the 20 of *February* at noon; it appears by your Journal that Prick muſt be to the Northwards of the place from which you departed 52 $\frac{2}{10}$ miles, and to the Eaſtward 57 $\frac{2}{10}$ miles.

Now inſtead of the *North* or *South* columns, you may more conveniently uſe the laſt column but one, ſhewing in what Latitude every account doth fall; and ſo it appears, that the Prick for the 20 of *February* muſt be in the Latitude of 33 deg. 17 min. Therefore in the Meridian of the *Summer-Iſlands* from which you departed make a prick in the *Latitude* of 33 deg. 17 min. and from that prick ſet down to the Eaſtwards in the ſame Latitude 57 $\frac{2}{10}$ miles, and where it ends is the Traverſe-point anſwering to the 20 of *February*: the like may be done for the 21 day, and ſo for all the reſt. This 58 miles may be taken in the meridian from the Latitude of 32 deg. 22 min. to the *Latitude* of 33 deg. 20 min. or otherwiſe you may take the half of it which is 29 miles about the middle between both latitudes, and double it.

But it is ſufficient to ſet down the ſums of every two or three dayes accounts, or ſo often as there is any notable Difference in your Courſe; Thus if you would make a prick in the *Chart*, anſwering to the 21 of *February*, being the firſt ſumme; I ſee by the Journal, that it muſt be in the *Latitude* of 34 deg. 24 min. and to the Eaſtwards of the place from which I departed 132 $\frac{2}{10}$ miles. Therefore in the meridian of the place from whence I departed, I make a prick in the *Latitude* of 34 deg. 24 min. and from that prick I ſet in the ſame *Latitude* to the *Eaſtwards* 132 $\frac{2}{10}$ miles, and where it ends is the Traverſe-point anſwering to the 21 of *February*, being the firſt ſum. This 132 miles may be taken in the meridian within, or a little without the two Latitudes, as before, namely, from 32 deg. 20 min. to 34 deg. 32 min.

In like ſort, if you would make a prick for the ſecond ſum, being the 24 of *Febrnary*, it there appears that it muſt be in the Latitude of 39 degr. 36 min. and to the *Eaſtwards* of the Traverſe

verſe point laſt before made 430 miles; therefore in the meridian of that Traverſe point I make a prick in the Latitude of 39 deg. 36 min. and from that Prick I ſet to the Eaſtwards in the ſame Latitude 430 miles, and where that ends is the Traverſe-point anſwering to the 24 day, and the like is to be underſtood of all the reſt.

Now this 430 miles may be taken ſeveral wayes; for firſt, if I take one Degree about the middle of that part of the meridian, which is intercepted between the Latitudes of the two places (as from 36 deg. 30 min. to 37 deg. 30 min.) and that degree ſeven times taken is 420 miles, then about the middle, namely, 37 d. I take 10 min. more, and ſo I have 430 miles.

In like manner, you may take two deg. or 120 miles, to meaſure it thereby, which may be taken from 36 degrees to 38 deg. and the reſidue about 37 degrees, as before, &c.

Or you may take the half of 430 miles, namely, 215 miles, which is 3 deg. 35 min. which muſt be taken as before, about the middle of that part of the meridian which is intercepted between the two Latitudes, and that doubled is 430 miles to be ſet to the Eaſtwards, as before.

And thus may this or any other Reckoning be ſet down without knowledge of the Longitudes, but more aptly and exactly by ſome Longitudes known, for then ſhall you have in the two laſt columns the ſubſtance and principal ſcope of your reckoning; namely, the Latitudes and Longitudes of all places, as you ſail, which may more eaſily and exactly be expreſt upon this Chart, then the Eaſterly or Weſterly diſtances; Therefore how this alſo may be done, we will ſhew, but firſt ſomething touching the *Compaſſe* and the *Variation* thereof, which ought not to be neglected in a reckoning.

CHAP. X.

Of the Variation of the Compasse, and how to rectifie a Course by the Variation known.

AMongst all the mysteries which God hath of late years discovered to the World for the furtherance of *Navigation*, there is none more necessary, nor yet more admirable then that property of the *Needle* touched with the Load-stone, whereby in the Vast Ocean where all Land-marks fail, yea even in the darkest nights and closest weather, when neither Sunne nor Starres are to be seen: The mariner (as it were by a messenger sent from Heaven) is taught which way to direct his ship; yea, as it were accompanyed with a guide towards his desired Port.

For the needle touched, besides other strange properties, hath this, to point out in all quarters of the World, the North and South parts of the Horizon, and so having a Card thereto fitted with Rumbs and Degrees, it sheweth all Points of the Compasse, and degrees of the Horizon.

Yet very seldome exactly of it self, without some further Art and Industry of him that useth it; for though in some places it swerves not, yet in most parts of the World the North and South points of the Needle have some *Variation* from the true North and South points of the Horizon to the Eastwards or to the Westwards, which how to discover in kind and quantity, we have shewed heretofore.

It may be thought, (and some men otherwise learned before this Property was fully discovered, have said) that this should be some blemish and imperfection in a stone so precious; But it is so far from being an imperfection, that it makes it so much the more precious? Yet (as I have said) not without the industry of him that useth it. He that is negligent or unskilful to observe it, especially in long Voyages and various Courses, may be led into many dangers by it, because he frames not his mind to the Rule, but the Rule to his mind, imagining it to be what it is not:

and

and hence I ſuppoſe, ſprang that Cuſtome of placing the *Needle* or *Wyars* a point or half a point to the Eaſtwards of the North-point of the Card, thinking by this means to ſhun the labour of obſerving the Variation, which indeed they might, if the Variation were the ſame in all places, and at all times; but becauſe it is not, this doth often encreaſe the Errour.

But he that diligently obſerves the Variation, finds (as I ſay) no prejudice in it, onely it requires daily, or once in two or three dayes half an hours work; and this labour it doth abundantly recompence; for by this means he knowes at the preſent how to direct his Courſe, and for the future, by thoſe notes which he keeps of the *Variations* and *Latitudes* by him obſerved, he knows (comming that way again) when he draws neer to any of thoſe places where ſuch Obſervations were made, and ſo falls the more certainly with any place intended.

There is further diſcovered of late a motion or alteration in the Variation of the *Needle*, and this is ſcarce yet certainly diſcovered. But comparing the Variations which were obſerved about fifty years paſt, with the preſent Variations: It appears they are leſſer Eaſterly, and more Weſterly by 6 or 7 degrees, then they were at that time. For whereas the Variation hath formerly been obſerved neer *London* to be 11 ¼ Deg. to the Eaſtwards, it doth now ſcarce exceed 4 Degrees. And there is the like alteration (as I have heard by ſome mariners) in other parts of the World; which we now leave to the further diſcovery of time and induſtry, and come to ſhew how to rectifie a Courſe by the Variation known.

The point of the Compaſſe upon which you ſail, and the Variation of the Needle known, to find the Rumb or Degree upon which the Ship hath made her way.

IT is beſt that the *Needle* or *Wyars* be placed directly under the *Flower de luce*, or *North* and *South* points of the *Card*, and ſo in the Rules following we preſuppoſe them to be. Now then it is to be underſtood, that the *Needle* having Variation

(as for the moſt part it hath) the ſhip doth not make her way upon that Rumb or Point of the Compaſſe, which ſhe ſeems to ſail upon, but either more to the right hand or to the left, according as the Variation is towards the right hand, or towards the left, and that ſo much towards the one ſide, or towards the other as that Variation is: We ſpeak not here of *Leeward-way*, but of the Variation onely. Therefore for the ſolution of this *Probleme* you muſt know how much the Variation is, and which way; And how this may be done, we have briefly ſhewed upon the 12 Caſe of *Right angled ſpherical Triangles*, and the 11 of *Oblique*, which known, you may find the angle of the Rumb or Line of your ſhips way of the *Meridian*: being the thing in this *Probleme* required.

A Table of the Angles of every Point and half Point of the Compaſſe with the Meridian.

	North	South	D. M.	North	South
			00 00		
½			05 37		
1	N by E	S by W	11 15	N by W	S by E
1 ½			16 52		
2	N N E	S S W	22 30	N N W	S S E
2 ½			28 07		
3	N E by N	S W by S	33 45	N W by N	S E by S
3 ½			39 22		
4	N E	S W	45 00	N W	S E
4 ½			50 37		
5	N E by E	S W by W	56 15	N W by W	S E by E
5 ½			61 52		
6	E N E	W S W	67 30	W N W	E S E
6 ½			73 07		
7	E by N	W by S	78 45	W by N	E by S
7 ½			84 22		
8	East	West	90 00	West	East
	Adde East variation Subſtract Weſt.			Adde Weſt variation Subtract East.	

For

For the effecting whereof, we will ſet down two wayes; the one by the Pen alone, the other inſtrumentally. If you do it by the Pen alone, although it be not hard to find what angle every point or half point makes with the Meridian; yet for your further eaſe herein, I have expreſſed the ſame in the Table before-going; the quarters of Points I have omitted, becauſe the ſteerage upon a quarter of a point is very uncertain, (the points being undivided as uſually they are) for a man by his eye is able to gueſſe very neerly which is the middle between two points, but he cannot gueſſe ſo neerly, which is the fourth part. Yet if you deſire any quarter, you may adde to the next before-going almoſt 3 deg. namely 2 deg. 49 min.

Now then by the magnetical Rumb or Point of the Compaſſe and Variation given, to find the true Rumb, you are to obſerve theſe two Rules following.

1. *If the Rumb and the Variation be both the ſame way from the Meridian (namely, both to the right hand, or both to the left) adde them together, and that ſumme is the true Rumb from that part of the Meridian.*

Yet if that ſumme exceed 90 degrees, ſubtract it from 180 *degrees, the remainer is the Rumb from the oppoſite part of the Meridian.*

2. *If the one be towards the right hand, the other towards the left, ſubſtract the variation from the Rumb, and the remainer is the true Rumb.*

Yet if the Rumb be the ſmaller number, ſubſtract it from the Variation, and the remainer is the true Rumb the other way.

Theſe Rules we ſhall indeavour to illuſtrate by examples following.

But firſt, for diſtinction-ſake we ſay the Rumbs or degrees from the North towards the Eaſt, are towards the right hand, and ſo from the South towards the Weſt; but from the North to the Weſtwards, on the left hand, and ſo from the South Eaſtwards: For a mans face being towards the North, the Eaſt is on his right hand, and the VVeſt on his left, &c.

In like ſort for the *variation of the Compaſſe*, if it have Eaſterly *variation*, that is, if the *Needle* and *Flower de luce* of the *Card* ſtand

ſtand to the Eaſtwards of the North, we ſay that *Variation* is towards the right hand, for not onely the North point, but all the other points of the *Compaſſe* direct a Courſe more towards the right hand then they would do, if there were no *Variation*. And ſo if it have Weſterly *Variation*; that is, if the *Needle* and *Flower de luce* ſtand to the Weſtwards of the true North point of the *Horizon*, we ſay that *Variation* is towards the left hand; forasmuch as not onely the North-point, but all the other points of the Compaſſe, ſtand more towards the left hand then they would do, if there were no *Variation*, this being premiſed, we come to give *Examples* of the two Rules before-going.

1 Let the Magnetical Rumb or Point of the *Compaſſe* be Northeaſt, and the *Variation* 10 degrees to the Eaſtwards; I demand the true *Rumb*?

Here the *Rumb* and *Variation* are both one way; that is, both towards the right hand; therefore,

To the Magnetical Rumb being N. Eaſterly	45 deg. 0 m.
Adde the Variation Eaſterly	10 deg. 0 m.
The ſumme is the true Rumb N. Eaſterly,	55 deg. 0 m.

2 Admit a ſhip ſail upon the North-point of the Compaſſe, and that the Variation be 10 deg. to the Eaſtwards, how doth ſhe make her way?

The magnetical Rumb is North, that is,	0 deg. 0 m.
To which adding the Eaſterly Variation	10 deg. 0 m.
The ſumme is the angle from the North part of the meridian to the Eaſtwards	10 deg. 0 m.

Which is almoſt *N* by *Eaſt*, & ſo hath ths ſhip made her way.

3 Let the point of the Compaſſe be East $\frac{1}{2}$ point Northerly, that is, from the North to the Eaſtwards $7\frac{1}{2}$ points, which is 84 deg. 22 min. and the Variation as before 10 deg. to the Eaſtward, I demand the true Rumb?

To the magnetical Rumb being Northeaſt,	84 deg. 22 m.
Adde the Eaſterly Variation	10 deg. 00 m.
The ſumme is the angle from the North	94 deg. 22 m.
Which ſubtracted from	180 deg. 00 m.
There reſts the true Rumb South-eaſterly	85 deg. 38 m.

4 *Ex-*

4 *Example.* Let the course by the Compasse be West and by South, that is, 7 points from the South to the Westwards, or 78 deg. 45 min. and let the Variation be as before 10 deg. to the Eastwards, what is the true Rumb?

To the Magnetical Rumb *S Westerly*	78 deg. 45 min.
Adde the *Easterly Variation*	10 deg. 00 min.
The summe is the true Rumb *S Westerly*	88 deg. 45 min.

You may conceive that the *Rumb* and *Variation* are here both one way; namely, both from the *Meridian* towards the right hand. For the Variation of the *North* point is from the *North* towards the *East*, and consequently of the *South* point from the *South* towards the *West*, both towards the right hand of the *Meridian*, as the *Rumb* is.

5 *Example.* Let the course by the *Compasse* be *West*, that is, from the *South* to the *Westwards* 8 points or 90 degrees, and let the Variation be as before 10 deg. to the *Eastwards*, I would know the true Course or Rumb?

To the Magnetical Rumb South-west	90 deg. 0 min
Adde the Variation *Easterly*	10 deg. 0 min
The summe is the angle with the *South* part of the *Meridian*	100 deg. 0 min.
Which substracted from	180 deg. 0 min.
There rests the true Rumb *N West*	80 deg 0 min.

Let the Course by the *Compasse* be *West*, that is, from the *North* to the *Westwards* 8 points or 90 degrees, and let the *Variation* be 10 deg. to the *Westwards*: I demand the true Rumb?

To the Magnetical Rumb *N West*	90 deg. 0 min.
Adde the Variation *Westerly*	10 deg. 0 min.
The summe is	100 deg. 0 min.
Which substracted from	180 deg. 0 min.
There remains the true Rumb *S West*	80 deg. 0 min.

Object. The Magnetical Rumb being here west 90 deg. why should it not aswell be counted from the *South* as from the *North*?

Answ. It may be counted from either, for as it is counted here from the North to the Westwards it falls under the first *Rule*, because

becauſe the Variation is the ſame way: But if it be reckoned from the South to the Weſtwards, it falls under the ſecond Rule, whereof we now come to give ſome Examples, ſuppoſing theſe already given ſufficient to illuſtrate the firſt Rule?

7 *Example.* Let the point of the Compaſſe be N N W and the Variation 10 deg. Eaſterly, I demand the true Rumb:

From the magnetical Rumb N W	12 deg. 30 m.
Subtract the Eaſterly Variation	10 deg. 00 m.
The remainer is the true Rumb N W	12 deg. 30 m.

8 *Example.* Let the point of the *Compaſſe* be North, and the Variation Eaſterly 10 deg. what is the true Rumb?

From the Eaſterly Variation	10 deg. 0 min.
Subſtract the Magnetical Rumb N w.	00 deg. 0 min.
The remainer is the true Rumb, the other way, namely N *E*	10 deg. 0 min.

Object. The magnetical Rumb may aſwell be named North eaſterly 0 deg. 0 min.

Anſw. It may, but then it is ſubject to the firſt Rule, as in the ſecond *Example.*

9 *Example.* Let the Courſe by the *Compaſſe* be Weſt, that is, from the North to the Weſtwards 8 points, or 90 degrees, and let the variation be as before 10 degrees to the Eaſtwards, what is the true Rumb.

From the magnetical Rumb N w	90 deg. 00 min.
Subſtract the eaſterly variation	10 deg. 00 min.
There reſts the true Rumb N w	80 d g. 00 min.

Here the Magnetical Rumb might aſwell have been South-weſterly 90 degr. and ſo it had fallen under the firſt Rule, as in the fifth example.

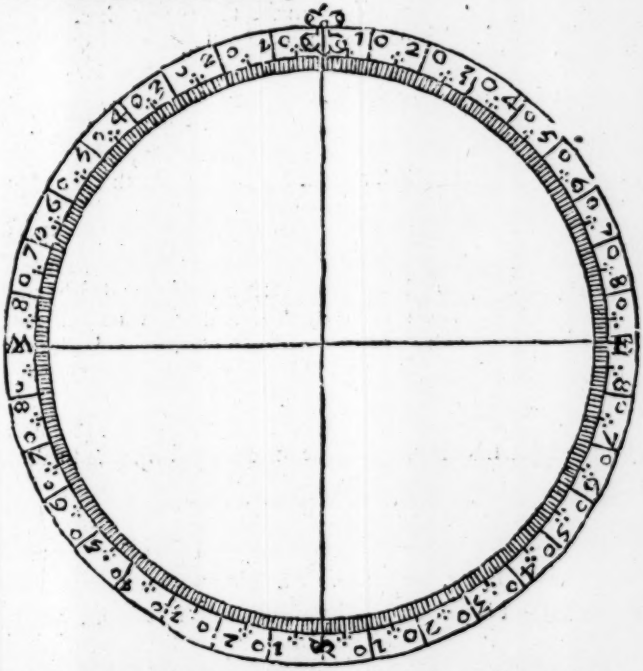
10 *Example.* Let the Courſe by the Compaſſe be Weſt; that is, from the South to the weſtwards 8 points or 90 degrees, and let the variation be 10 deg. to the weſtwards, I demand the true Rumb?

From the magnetical Rumb S w.	90 deg. 0 min.
Subtract the *Weſterly* variation	10 deg. 0 min.
The remainer is the true Rumb S w	80 deg. 0 min.

If

If the Rumb here had been reckoned from the North, as in the ſixth *Example*, it had fallen under the firſt *Rule*.

And this may ſuffice for the illuſtration of the two former Rules in the ſolution of this *Problem*.



The ſame may alſo more eaſily be reſolved, by ſuch an *Inſtrument* as is here deſcribed, conſiſting of two *Circles*, the one being the nethermoſt divided into four Quadrants, and every of thoſe into 90 deg. numbred from the *North* and *South* points, towards the *Eaſt* and *Weſt*.

The other being the uppermoſt and moveable about the *Center* divided, as the Card of the Compaſſe into XXXII *Points*, and thoſe again ſub-divided into *halves* and *quarters*.

By this you may readily find the true Rumb for any Course and Variation given.

For if you turn the North point of the upper Circle, from the North point of the lower, so many deg. and the same way that the Variation is, and then look in the same upper Circle for the magnetical Course or point of the Compasse proposed, you shall find right under it in the neather Circle what number of degrees the same is distant from the N. or S. points of the true meridian towards the E. or W. which is the true Rumb here required.

As suppose the Variation to be 10 deg. Easterly, and the course by the Compasse East half a point Northerly, and there be required the true Rumb?

Turn the North-point of the upper Circle from the North-point of the lower 10 deg to the Eastwards, and then I look in the upper Circle, for East half a point Northerly, and right under it in the nether Circle I find 85 deg. and about one half numbred from the South part of the meridian towards the East, therefore, I conclude that the true Rumb required is from the South towards the East, 85 $\frac{1}{2}$ degrees and something more.

By this *Instrument* also (if you use the pen onely, as before we shewed) you shall readily see when to add, and when to substract.

CHAP. XI.

To keep a reckoning of your longitude, and so to set down a reckoning by longitude, and latitude onely.

IN the Example before given of a *Journal*, we have in the twelfth and last column expressed in such places as it seemed most requisite, the *Longitudes*, we come now to shew how the same may be known, and first,

By the Rumb and Latitudes given: to find the Difference of Longitude

As *Radius* is in proportion, to the Tangent of the Rumb;
So is the Difference of Latitude in meridional parts,
To the Difference of Longitude in minutes.

As let the Rumb be North-easterly 48 degrees, and suppose a Ship to run upon this Rumb, from the Latitude of 32 degrees 25 min.

min. into the Latitude of 34 deg. 24 min. there is required the difference of Longitude. Here,

The meridional parts answering to 34 deg.		24 min.	2200
The meridional parts for	32	25	2058
The difference of latitude in such parts is			142

Say then, As *Radius* is in proportion

To the tangent of the Rumb,	48 d. 0 min.	10.0456
So the difference of latitude in merid. parts	142	2.1523
To the difference of Longitude in minutes	158	2.1979

These minutes converted into deg. are 2 deg. 38 min. which is the difference of Longitude required, as the same is expressed in the Journal against the 21 of *February*.

And thus sailing upon one and the same Rumb, you may find the difference of Longitude, and so often as you alter your Rumb, so often working by the same Rule, you shall have all the differences from place to place, which added together, make the whole difference of Longitude.

But you may also find the Difference of Longitude neer enough at one operation for many several Rumbs and Distances, provided that those Rumbs differ not much one from another. As in the former Journal from the 27 of *February*, till the second of *March*, I sail by several Rumbs and Distances from the Latitude of 43 deg. 55 m. into the Latitude of 48 deg. if you would finde the difference of Longitude hereto answerable at one operation, it may be done by this Rule;

As the difference of Longitude in miles,
Is to the departure from the meridian in miles.
So is the difference of Latitude in meridional parts,
To the difference of Longitude in minutes.

As in that example, the difference of Latitude for all those Courses, as in the North column appears is 2444.

The departure from the meridian, as there in the East column appears is 6301.

The merid. parts for the latitude of 43 deg. 55 min. are	2939
The merid. parts for the latitude of 48 d. 0 m. are	3292
Difference of latitude in meridional parts is	353

Say then, As the difference of Latitude 2444 *co. ar.* 6. 6119
To the departure from the *Meridian* 6301 3. 7994
So the difference of Latitude in *Merid.* parts 353 2. 5478
To the difference of Longitude in minutes, 910 2. 9591
Which reduced into degrees, is 15 deg. 10 min. And added to the former Longitude 21 deg. 28 min.
Gives the present Longitude 36 deg. 18 m. for the 2 of *March.*

The like may be done for the account from the second of *March* to the fifth of the same, &c.

But if your Courses and Distances run, be all neer to one and the same Parallel or Latitude (as in this Journal they are from the 5 of *March* to the 8, and from the 8 to the 10) then it is sufficient to finde what Longitude in that Parallel is answerable to the miles of Easting or Westing, or departure from the *Meridian* by this Rule.

As the sine complement of the Latitude of that Parallel,
Is in proportion to *Radius*;
So is the number of miles in that Parallel,
To the difference of Longitude in minutes.

As from the 5 of *March* to the 8. the Latitude was neer 50 deg. the Easterly distance 186 $\frac{8}{10}$ miles: therefore for the difference of Longitude, say:

As sine complement the Latitude, *s. c.* 50 deg. 0 min. 1919
To *Radius*;
So is the departure from the *Meridian* 186 8 3.2714
To the difference of Longitude 290 6 3.4633

Thus it appears, the difference of Longitude is almost 291 minutes, which is 4 deg. 51 min. and this added to 5. the Longitude upon the 5 of *March*, namely, to 46 deg. 52 min. the sum is 51 deg. 43 min. the Longitude upon the 8 of *March*: the like might be done for the 10 of *March.*

And though this last Rule be then fittest to be used, when your Course is near East and West, or your difference of Latitude little; yet it may also be used at other times instead of the two former, without any great errour, if you take the middle degree of Latitude, or somewhat more, as in the former Example.

The

The Latitude upon the 27 of *February* is 43 deg. 55 min.
The Latitude upon the ſecond of *March* is 48 deg. 0 min.
The middle Latitude or ſomewhat more is 46 deg. 10 min.

Say then, As ſine comp. the latitude *is* 46 deg. 10 m. .1595
To Radius,
So the Eaſting or departure from the meridian 630. 1. 3.7004
To the difference of longitude, 909. 7. 3 9589

Which is almoſt 910 min. or 15 deg. 10 m. as before.

And thus you may in the 12th. and laſt column of your Journal, ſet down your longitude ſo often as you think it requiſite; and ſo in the two laſt columns you ſhall have the Subſtance and principal ſcope of your Reckoning, namely, your latitudes and longitudes, which whenſoever you deſire to ſet down in *Mercators Chart*, or in the *polar Chart*, or in any other, graduated with degrees of longitude and latitude, you may readily do it.

As if I would ſet down the ſumme of the foreſaid *Journal*, from the 19 of *February* to the 10 of *March*, I find againſe the 10 of *March* the latitude to be 49 deg. 54 min. and the difference of longitude 54 deg. 53 min. Therefore in the latitude of 49 deg. 54 min. I draw an occult parallel, and reckoning from the *Summer-Iſlands* towards the Eaſt 54 deg. 53 min. I draw by that longitude an occult meridian, the interſection of this meridian with the foreſaid Parallel is the Traverſe-point, or the point repreſenting the place of the Ship, and the like is to be underſtood of any other.

This form of keeping and expreſſing a Reckoning, is (as I conceive) moſt apt and agreable (of all others that I have ſeen or thought upon) to all ſorts of *Charts* or *Maps*, and to the *Globe* it ſelf; and to all the kinds or wayes of Sailing, that are or may be uſed. We will here adde ſome other Propoſitions which may ſometimes be of good and neceſſary uſe in it.

The Rumb and Difference of Latitude given: to find by the Table, the diſtance in the Rumb, and the Departure from the Meridian thereto anſwerable, &c.

HOw to find the Northing or Southing, that is, the Diſtance in latitude, as alſo the Eaſting or Weſting, that is, the Diſtance:

ſtance in Longitude or departure from the meridian of any Rumb, for any diſtance run upon it we have before ſhewed, the like operation is in theſe Propoſitions following: namely,

2 *The Rumb and diſtance in latitude geven: to finde the diſtance in the Rumb, and the Eaſting or Weſting.*

3 *The diſtance and difference in latitude given: to finde the departure from the Meridian and the Rumb.*

4 *The difference in latitude, and departure from the Meridian given: to find the Courſe and Diſtance.*

5 *The Courſe and Departure from the Meridian given: to find the Difference of latitude and Diſtance.*

6 *The Diſtance and Departure from the Meridian given: to find the Courſe and difference of latitude.*

So that with the firſt before-handled, here are ſix Propoſitions, and in every of them two things required; and ſo they become twelve. We will not ſtand to give examples of them all, but onely of thoſe which are moſt uſeful, the reſt may by them be conceived.

And firſt, to find the Eaſting or Weſting of any *Rumb* for any difference of Latitude.

Admit a ſhip run North-eaſterly 60 degr. (that is, N E by E, and almoſt half a point Eaſterly) till ſhe have altered the latitude 42 min. how much is ſhe departed from the meridian?

I run down the column under 60 deg. till I find 42 miles, or 420 tenths, and againſt it in the adjacent column I find 728 tenths, that is almoſt 73 miles, which is the departure from the meridian to the Eaſtwards.

If you would alſo have the Diſtance upon the Rumb, it is right againſt theſe numbers in the column of *Diſtances*, being in this Example 84 miles.

2 *Example.* But admit ſhe run North-eaſterly 60 deg. till ſhe alter her latitude 1 deg. 32 m, what is the Eaſterly diſtance?

This 1 deg. 32 min. is 92 miles, or 920 tenths, for which if I look in the column under 60 deg I find no number ſo great, but the greateſt number there is 500, which ſubtracted from 920, there remains 420, therefore in that column under 60 d.

100	500	866
84	420	728
184	920	1594

I look for theſe two numbers, namely, 500, and 420, and againſt the firſt in the adjacent column I find 866, and againſt the ſecond 728, which I ſet againſt them as above appeareth and ſo adding them, I find for this difference of Latitude, the departure from the meridian to be 159 $\frac{4}{10}$ miles.

If further you deſire the Diſtance run upon this Rumb, you have it in the column of Diſtances, right againſt the ſame numbers, as in the example above appeareth; where being added, it amounts to 184 miles.

The Diſtance and difference in Latitude given: to find the Rumb and departure from the Meridian.

ADmit a ſhip run upon ſome Rumb between the North and the East 74 miles, and then have altered her Latitude 42 m. the queſtion is, upon what Rumb hath ſhe run, and how many miles is ſhe to the Eaſtward in Longitude.

I run croſſe the Table towards the right hand, looking in every firſt column of Diſtances for 84, till I finde againſt it in one of the adjacent columns 420, at the top of which column over 420, there is 60 deg. ſhewing the Rumb to be North-eaſterly 60 deg. alſo againſt 420 in the adjacent column I find 788, which ſheweth the Diſtance to the Eaſtwards to be almoſt 73 miles.

2 *Example.* But if the Diſtance run be 184 miles, and the difference of latitude 1 deg. 32 min. and there be required the Rumb and Diſtance to the Eaſtwards?

Becauſe the Column of Diſtances extends but to 100 miles, and the Diſtance here given is 184 miles, you may take the half thereof, which is 92 miles, and likewiſe the half of 1 deg. 32 min. which is 46 miles, or 460 tenths, and then look, as before, where you find 460 againſt 92, for there in the top of the column you ſhall find the Rumb, which in this example is 60 deg. ſhewing that the Rumb is from the North Eaſterly 60 deg. and in the adjacent column againſt 92 and 460, you ſhall find 797, which doubled (becauſe it is for the half) is 1594, ſhewing that the departure from the meridian to the Eaſtwards is 159 $\frac{4}{10}$ miles, Theſe and the reſt may alſo be performed by the *Doctrine of plain triangles*, as we have formerly ſhewed.

CHAP.

CHAP. XII.

Certain Problems touching Currents.

ALthough the time be already expired which I assigned for this Work, and mine own more urgent occasions call me away: yet seeing it is necessary in Navigation to take notice of Currents, and to make a competent allowance for them: I will briefly set down certain *Problemes*, such as I have sometimes thought upon, whereby a man may the better conceive and judge of that allowance, the rather for that I know not any that hath handled it.

First, then it is to be conceived, that a Ship or other Vessel sailing or rowing where there is a Current hath a compound motion arising of two different Principles; namely, of the Current and Ships way, so that here are three Motions to be considered, namely, two simple, and the third compounded of them. The first simple motion is that of the Current, whereby it moveth, and is apt to move other things that are in it, the same way. The second of the Ship or Boat, as it moveth by wind or oares, or is apt to be moved, if there were no current: The third, compounded of them, is the line of the Ships true motion. The first, we call the way, or motion of the Current: the second, the way or simple motion of the Ship, the third, her compound or true way. The two simple motions being either of them according to right lines and uniform (as in the *Problemes* following, we suppose them to be.) The third also, which is composed of them is a right line; For whether the Ship sail directly opposite against the Current, or directly with it the same way, or whether the one crosse the other at right angles or at oblique, yet still either motion being direct and uniform, they both together beget a right lined uniform motion, because the one retaineth to the other one and the same proportion in every point. And according to these grounds we proceed in the Problemes following, to determine the proportions of every of these Motions, and the angles which they make one with another.

1 *Ad-*

1 *Admit a Current run East 3 miles an hour, and that a ſhip under ſail run West directly againſt it 6 miles an hour in her ſimple motion; what is her true or compound motion?*

From the ſhips ſimple motion	6 miles
Subtract the Current	3 miles
The remainer is the ſhips true motion	3 miles

So the ſhips true way is to the weſtwards 3 miles an hour.

2 *Admit a Current run weſt 6 miles an hour, and that a ſhip under ſail run directly againſt it, 5 miles an hour by the Log: what is the ſhips compound motion, and which way?*

From the Current being the greater	6 miles
Subſtract the ſhips ſimple motion	5 miles
There remains the ſhips true motion	1 mile

Which 1 mile ſhews, that the ſhip by her compound motion falls a ſtern, that is, moves to the weſtwards 1 mile an hour.

In the Experimental practice of the two former *Problems*, it may ſeem that a ſhip or Boat ſo ordered, hath alſo a motion to the right hand, or to the left, but this comes to paſſe, becauſe it is hard, and in a manner impoſſible to ſtemme a Tide or Stream ſo exactly, but that the ſhip will ſwerve, (or yaw as they ſay) either to the one ſide, or to the other.

3 *Admit a Current run East 3 miles an hour, and that the ſhip alſo run East 3 miles an hour by the Log, what is the ſhips true motion?*

To the ſhips ſimple motion	3 miles
Adde the Current	3 miles
The ſumme is the ſhips true motion	6 miles

So the ſhips compound or true way is East 6 miles an hour.

4 *Admit a Current run East two miles an hour, and the ſhip South 6 miles an hour; what is the ſhips true motion, and which way?*

In handling of any Art, to avoid circumlocution, there are uſed terms or words of Art, ſerving to expreſſe briefly the things handled. And foraſmuch as this ſubject hath not been formerly handled, nor the Principles or Grounds thereof laid (ſo farre as I know) we will adde a few ſuch terms as may ſeem moſt neceſſary, expreſſing here what we mean by them.

Let the line A B run from A to the ſouthwards, and B D from B to the Eaſtwards, and let A B be in proportion to B D, as 6 to 2, or 3 to 1.

Then doth A B repreſent the line of the ſhips ſimple motion, B D the motion of the Current, and A D the compound motion of the ſhip.

And D A B is the angle contained between the line of the ſhips ſimple motion, and the line of her compound or true motion, which for brevities ſake we will henceforth call the *Angle of Deflection.* Alſo A D B is the angle contained between the line of the ſhips compound motion, and the ſett or drift of the Current, which we will call the *Angle of Reflection.*

Laſtly, A B D is the angle contained between the line of the ſhips ſimple motion, and the ſet of the Current, which we will call the *Angle of Incidence.*

Then for the Rumb, the Proportion is thus:

As the ſimple motion	A B 6 miles	*co. ar.*	9.2219
Is to the Current	B D 2 miles		0.3011
So is *Radius*			
To the tangent of Deflection	*t* D A B 18 deg. 26 min.		9.5230

So the Rumb upon which the ſhip makes her way good is ſouth 18 degr. 26 min. Eaſterly, that is, *S S E* 4 degrees 4 minutes ſoutherly.

2 *For the ſhips true way, or compound motion.*

As the ſine of the Deflection	*s* D A B 18 deg. 26 min.		0.5000
To the Current	D B 2 miles		0.3011
So *Radius*			
To the true motion	A D $6\frac{33}{100}$		0.8011

So the ſhips compound motion is $6\frac{33}{100}$ miles hourly, that is $6\frac{1}{3}$ miles almoſt.

5 *A ſhip ſails Weſt five dayes together by the Log 725 miles, but there is a Current, all this while ſetting to the Southwards* $1\frac{1}{2}$ *mile an hour: I demand how ſhe hath ſailed, and how far?*

The Current ſetting $1\frac{1}{2}$ mile an hour, ſets in 5 dayes 180 miles?

Therefore,

As the ſimple motion	A B 725 miles	7.1397
Is to the Current	D B 180 miles	2.2553
So is *Radius*,		
To the tangent of Deflection	*t* D A B 13 d. 57 m.	9.3950

For the Diſtance.

As ſine compl. the Deflection	*s c* D A B 13 d. 57 m.	0.0130
Is to the ſimple motion A B	725 miles	2.8603
So is Radius		
To the compound motion A D,	747 miles.	2.8733

So the ſhips true way is Weſt ſoutherly 13 deg. 57 min. or South-weſterly 76 deg. 3 min. 747 miles.

6 *A ſhip ſails Weſt five dayes together by the Log* 725 miles, *in a Current ſetting to the Southwards, and then he finds that he hath altered his Latitude* 3 *degrees; I demand the motion of the Current, the true Rumb, and true way of the ſhip?*

This Queſtion differeth little from the former, for ſeeing the difference of Latitude is 3 deg. the motion of the Current is 180 miles: ſo there is given the ſhips ſimple motion, and the motion of the Current, as before, &c.

7 *A ſhip in* 6 *hours ſails from a certain* Cape *or Head-land South* 30 *miles by the Log, in a Current ſetting Eaſterly, and then obſerving the ſame Cape, he finds that it bears N N W; I demand how faſt that Current ſets, and how farre he hath ſailed?*

As let a ſhip ſail from A towards B ſouth 30 miles, but by means of the Current, ſhe is driven more Eaſterly, namely to D, from whence ſetting the Cape A, it is found to bear *N N W.* And ſeeing the Current ſets from B towards D Eaſterly; therefore the angle of Reflection B D A is 6 points, that is 67 deg. 30 min. Here then is demanded the diſtance A D, and the drift of the Current in that time B D.

As the ſine of the angle of Reflection	*s* B D A 67 d. 30 m.	.0344
To the ſimple motion of the ſhip	A B 30 miles	1.4771
So the ſine of the angle of Deflection	*s* D A B 22 d. 30 m.	9.5736
To the motion of the Current	B D 12	1.0581

And further,

As the sine of the angle of Reflection ſ BDA 67d.30 m. 0344
To the diſtance run by the Log A B 30 miles, 1.4771
So is Radius
To the compound motion of the ſhip A D, $32\frac{47}{60}$ 1.5115

And thus we finde that Current to ſet $12\frac{1}{10\frac{1}{2}}$; that is, near $12\frac{1}{2}$ miles in 6 hours, and the diſtance run to be $32\frac{1}{2}$ miles almoſt.

That the thing may be better conceived, we will uſe two or three Examples more familiar and obvious to every mans experience; yet grounded upon the ſame Principles and Reaſons.

8 *Admit that* Tulis-ſtairs *bear from* Billingſgate-ſtairs *S. W Southerly, namely, South-weſterly* 40 *degrees, and be diſtant* 30 *Poles: and ſuppoſe the tide of Ebbe to run there Eaſtward* $2\frac{1}{3}$ *miles an hour, and that a pair of Oares, rowing* $4\frac{1}{3}$ *miles an hour, would go ſtraight over from the firſt to the ſecond: how ſhall they row over, namely, upon what degree or point of the Compaſſe, and how far ſhall they row to get thither, and in what time?*

Let A repreſent *Billinſgate-ſtairs*, D *Tulis-ſtairs*, A E the ſimple motion of the Boat, E D the motion of the Current, then is A the angle of Deflection, E the angle of Incidence; D the angle of Reflection 130 degr. or 50 degress.

As the ſimple motion of the Boat A E $4\frac{1}{3}$ miles 9.34679
Is to the motion of the tide D E $2\frac{1}{3}$ miles 0.39794
So the ſine of Reflection D ſ 50 deg. 9.88425
To the ſine of Deflection A ſ 23 d. 3 m. 9.62898

Thus the poſition, from A to D, being ſouth-weſterly 40 deg.

deg. and the angle of Deflection A 23 deg. 3 min. the position from A towards E, is South-westerly 63 degr. 3 min. that is, WSW Southerly. And so must those Oares row to go straight over.

Secondly, for the distance A E.

From the angle of Reflection	D	50 deg. 00 min.
Substract the angle of Deflection	A	23 deg. 03 min.
And there rests the angle of Incidence	E	26 deg. 57 min.

As the sine of Incidence	*s* E 26 d. 57 m.	0.34370
Is to the true distance	A D 80 poles	1.90309
So the sine of Reflection	*s* D 50 deg. 0 min.	9.88425
To the simple motion	A E 135 $\frac{3}{10}$ poles	2.13104

Lastly, for the time, seeing 320 Poles make a mile, and they row 4 $\frac{1}{2}$ miles in an hour, it is 1440 Poles in an hour: so the proportion is,

As the simple hourly motion	1440	6.8416
To the simple motion before found	135 $\frac{3}{10}$	2.1310
So is an hour in minutes, namely,	60 min.	1.7781
To the time required in minutes	5 $\frac{63}{100}$	0.7507

And so long will they be rowing.

9 *But suppose they will row harder, to go a shorter cutt; namely, to go South-west by West, how fast must they go to row straight over, and how far, and in what time?*

Then seeing the Position from A to D is South-westerly 40 deg. and S W by W is South-westerly 56 deg. 15 min. therefore the angle of Deflection at A is 16 deg. 15 min. the angle of Reflection D as before, 50 deg. 0 min. the angle of Incidence E is 33 deg. 45 min.

As the sine of Deflection	*s* A 16 deg. 15 min.	.55311
To the motion of the tide	*D* E 2 $\frac{1}{2}$ miles	0.39794
So the sine of the angle of Reflection	D 50 deg. 0 min.	9.88425
To the simple hourly motion of the Boat	A E 6 $\frac{844}{1000}$	0.83530

And such is the hourly motion of the Boat, namely, 6 $\frac{844}{1000}$ miles in an hour.

Secondly,

Secondly, for the ſimple motion.

As the ſine of Incidence	*s* E 33 d. 45 m.	0.25526
Is to the true diſtance	A D 80 poles	1.90309
So the ſine of Reflection	*s* D 50 deg. 0 min.	988-25
To the ſimple motion	A E 100 $\frac{3}{10}$ poles	2.04260

Thus it appears they muſt row 100 $\frac{3}{10}$ poles to get over.

Laſtly, for the time.

The hourly motion before found 6 $\frac{844}{1000}$ reduced into Poles, is 2190 $\frac{1}{10}$.

As the ſimple hourly motion	2190	6.65956
Is in proportion to an hour, or	60 min.	1.77815
So is the ſimple motion before-found	110 $\frac{3}{10}$	2.04260
To the time required	3 $\frac{022}{1000}$ min.	0.48031

And ſo long will they be rowing over.

10 *But admit a Sculler rowing three miles an hour, would croſs ſtraight over at the ſame time, upon what point muſt he row, and how far to get thither, and in what time will he do it?*

Firſt, for the angle of Poſition.

As the hourly motion of the Boat	A E 3 miles	9.52288
To the ſine of Reflection	D *s* 50 deg.	9.88425
So is the hourly motion of the ſtream	D E 2 $\frac{1}{2}$ miles	0.39704
To the ſine of Deflection	A *s* 39 d. 40 m.	9.80407

Now ſeeing the poſition from *Billingſgate* to *Tulis Stairs*, namely from A to D, is by ſuppoſition to the Weſtwards of the South 40 deg. and the angle of Deflection A is here found to be 39 deg. 40 min. therefore the poſition from A to E is from the South to the Weſtwards 79 deg. 40 m. which is Weſt and by South, and almoſt 1 deg. Weſterly, and ſo muſt that *Sculler* row to go ſtraight over. *Secondly, for the diſtance* A E.

From the angle of Reflection	D	50 deg. 00 min.
Subſtract the angle of Deflection	A	39 deg. 40 min.
And there reſts the angle of Incidence	E	10 deg. 20 min.

As the ſine of Incidence	*s* E 10 deg. 20 min.	.74624
To the true diſtance	A D 80 poles	1.90309
So is the ſine of Reflection	*s* D 50 deg. 0 min.	9.88425
To the ſimple motion	A E 341 $\frac{6}{10}$	2.53358

And

And thus it appears, that though the diſtance of the two places be but 80 Poles, yet if according to the queſtion, he row but after three miles an hour, and the ſtream ſet after 2 $\frac{1}{2}$ miles an hour, then he muſt row 341 $\frac{6}{10}$ poles to go ſtraight over.

Laſtly, for the time.

Three miles is 960 Poles, ſay then

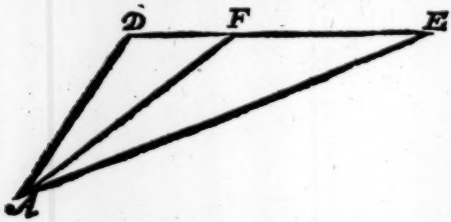
As the ſimple hourly motion	960	7.01778
To the ſimple motion before found	341 $\frac{6}{10}$	2.53355
So is an hour in minutes, namely,	60 min.	1.7781
To the time required in minutes	21 $\frac{35}{100}$	1.32946

And thus it appears that the time requiſite to row over, rowing 3 miles an hour; is 21 $\frac{35}{100}$ minutes, whereas we found before, that rowing there 4 $\frac{1}{2}$ miles an hour, they might row over in 5 $\frac{61}{200}$ minutes, which is little more then a fourth part of the time.

There might be other and that great variety of Queſtions of this nature propoſed and reſolved, many of good uſe in practice, which the Water-men by daily experience without other Rules, are able to gueſſe at ſomething neerly, ſufficing for their occaſions: my intent in theſe eſpecially to explicate the Compound motion of a Ship, or other Veſſel ſailing or rowing where there is a Current; which by ſuch familiar Examples may ſeem more evident. I cannot inſiſt upon them by reaſon of mine other occaſions, nor ſpend that time in theſe here handled, which elſe I ſhould have done; whence if any defect or miſtake ſhould ariſe, if the Reader be pleaſed to give me friendly notice of it, I ſhall as thankfully accept it, and reform it: We propoſe next a queſtion at Sea, which let be this.

11 *There is a Current at Sea ſetting Eaſt 12 miles in 24 hours, a ſhip ſails in the ſame from a certain Port Weſt South-weſt 6 dayes, and then returning thence, and ſailing NE by North 3 dayes, falls with the Port from whence he firſt departed, I demand what his dead Reckoning was outwards, and what back again, and how far theſe two Ports were aſunder, and upon what point of the Compaſſe?*

As



As let the Current ſet from E towards D, and let the firſt Por t be A, the ſecond F, and let the Courſe outward b ound be repreſented by A E, and the Courſe homewards by *D* A, &c.

And foraſmuch as *D* E is an Eaſt and weſt line, and A E weſt-ſouthweſt, therefore the angle at E is 22 deg. 30 min. and by the like reaſon, the angle at *D* is 123 deg. 45 min. or 56 deg. 15 m. and the angle at A 33 deg. 45 min. and E *D* being the ſetting of the Current for 9 dayes, is 108 miles.

Firſt then, for the dead Reckoning outward, namely A E.

As the ſine of the angle at A	ſ 33 deg. 45 min.	.25526
To the line *D* E 108 miles		2.03342
So is the ſine of the angle at *D*	ſ 56 deg. 15 min.	9.91985
To the line A E	161 $\frac{6}{10}$	2.2083

Thus A E his dead Reckoning outwards is 161 $\frac{6}{10}$.

Secondly, for A *D.*

As the ſine of the angle *D* A E	ſ 33 deg. 45 min.	.25526
Is to the line *D* E	108 miles	2.03342
So is the ſine of the angle *D* E A	ſ 22 deg. 30 min.	9.58084
To the line A *D*	74 $\frac{4}{10}$ miles	1.87152

Which 74 $\frac{4}{10}$ miles is his dead Reckoning homewards.

Thirdly, for the angle D A F *or* D F A.

To the ſide A *D* is found	74 $\frac{4}{10}$ miles.
The ſide *D* F for 3 dayes, is	36 miles.
The ſumme of both is	110 $\frac{4}{10}$
Their Difference is	38 $\frac{4}{10}$
The ſumme of the angles *D* A F and *D* F A	56 deg. 15 m.
The halfſumme is	28 deg. 7 $\frac{1}{2}$ m.

The

The proportion.

As the ſumme of the ſides	110 $\frac{4}{10}$	7.95703
Is to their difference	38 $\frac{4}{10}$	1.58433
So is the tangent of	28 deg. 07 $\frac{1}{2}$	9.72706
To the tangent of	10 deg 32 m.	9.26932

Which added together, make the angle DFA 38 deg. 39 $\frac{1}{2}$.

And ſeeing the rumbe from F to D is Eaſt, and the angle D F A 38 deg. 39 m. $\frac{1}{2}$, therefore the rumb from F to A is to the Northwards of the Eaſt 38 deg. 39 m. $\frac{1}{2}$, that is N E by E almoſt half a point Northerly, which is the rumbe from the ſecond port to the firſt.

Laſtly for A F *the diſtance of theſe two ports.*

As the ſine of the angle D F A, s 38 deg. 39 $\frac{1}{2}$		.20434
To the dead reckoning homewards	A *D* 74 $\frac{4}{10}$ miles	1.87152
So is the ſine of the angle *D* s 56 deg. 15 m.		9.91985
To the diſtance	A F 99 $\frac{02}{100}$ miles	1.99571

Thus the true diſtance of thoſe two ports is 99 miles, and ſomewhat more.

Sundry other queſtions of like nature might be propoſed, which to him that well underſtandeth, theſe will not be difficult.

Theſe Principles a little inlarged may further with a few Experiments be applyed in the diſcovery of ſome miſteries in compound motions not yet divulged; though much indeavoured by ſundry famous men in ſeveral parts of *Europe*, but theſe we ſhall not touch at preſent.

12 *To find where there is a Current at Sea, alſo which way it ſets, and how faſt.*

THis may be done by comparing the reckoning outwards with the reckoning homewards, whereof we will give an Example or two.

Firſt, admit a ſhip ſail from a certain Port, by one or ſeveral Rumbs or Diſtances, till ſhe arrive at a ſecond, and there finde reckoning by Courſe and Diſtance, that ſhe is more Southerly than the Port from which ſhe departed by 541 miles, and more Weſterly by 145 miles: But by his Reckoning homewards,

when he arrives again at the first place, he finds himself to the Northwards of the second 541 miles, as before, and to the Eastwards 305 miles. Now supposing he were three dayes outwards bound, and five dayes homewards bound, I would know which way the Current sets, and how fast? Here because the Easterly distance homewards is greater then the westerly distance outwards; therefore from the Easterly distance 305 miles, substract the westerly distance 145 miles, the remainer being 160 miles, is the motion of the Current to the Westwards.

And thus it appears, that that Current sets to the westwards, 160 miles in eight dayes, that is, 20 miles a day, or $\frac{5}{6}$ of a mile every hour.

2 *Example.* Admit a ship sail from the *Summer Islands*, by several Rumbs and distances, till she arrive at Cape *Codd* in *New England*, namely, from the East part of the *Summer-Islands* (the Variation being allowed) first, North 20 miles, and then N N W 150 miles, the second day N by W 180 miles: the

	North	*South*	*East*	*West*
North 20 miles	20 0			
North N W 150 miles	138 6			57 4
North by W 180 miles	176 5			35 1
North 90 miles	90 0			
Northeast 88 miles	62 2		62 2	
528 miles	487 3		62 2	92 5
				62 2
				30 3

third day North 90 miles, the fourth day N East 88 miles, and so arrive at Cape *Codd*: then by these Courses and Distances we may gather by the fore-going Table, that Cape *Codd* should by this Reckoning be to the Northwards 487 miles: and to the westwards 30 miles, as here appears.

Now suppose she sail back again from Cape *Codd* towards the *Summer-Islands*, the first day S S W 150 miles; the second day,

day S S W 160 miles; the third day S by W 130 miles; the fourth day South 140 miles; the fifth day East 110 miles, and so be come again to the East part of the *Summer-Islands*.

	North	*South*	*East*	*West*
South *S W* 150 miles	——	——	——	——
South *S W* 160 miles	——	1386	——	57 4
South by W 130 miles	——	1478	——	61 3
South 140 miles	——	1275	——	25 3
East 110 miles	——	1400	1100	
690 miles		5540	1100	144 0
				110 0
				34 0

These Courses and Distances make as here appeareth the *Summer-Islands* to be to the southwards of Cape *Codd* 554 miles, and to the Westwards 30 miles.

Therefore by this last Reckoning back again Cape *Codd* should be to the Northwards of the *Summer-Islands* 554 miles, and to the Eastwards 34 miles, whereas by the former reckonings outwards, it was to the Northwards onely 487 miles, and to the Westwards 30 miles; so that the Difference of these two reckonings outwards and back again is 67 miles Northerly, and 64 miles Easterly, which sheweth that the Current in that time, namely, in 9 dayes, hath set to the Northwards 67 miles, and to the Eastwards 64 miles; that is, Northeast little Northerly 93 miles, as by the fore-going Table doth appear, which is 10 $\frac{1}{3}$ miles every day.

And what we here done by the Tables might have been done (as the fore-going Problemes) by the Doctrine of plain triangles.

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FINIS.

The Names of ſuch Books as are printed and ſold by George Hurlock, *at* St. Magnus *Church-corner in* Thames *Street, neer* London *Bridge.*

THe Art of *Navigation*, by *Martin Curtis.* Safeguard of Saylors, or Great Rutter, by *Ro. Norman.* A Table of Gauging all manner of Veſſels, by *Jo. Goodwin.* Pathway to perfect ſailing, by *Richard Polter. Petiſcus* his Doctrine of Triangles with Canons. *Norwoods* Doctrine of Triangles with Logarithmes. *Norwoods* Epitomy, applyed to plain and Mercaters ſailing. *Norwoods* Seamans Practice, containing a Fundamental Probleme in *Navigation*, experimentally verified. Navigator, by Capt. *Charles Saltonſtal* newly printed, with additions, ſhewing the Deceipts of the Plain Charts uſed in our time, and a way to prove the projection of any Plain Chart. *Daty's* deſcription and uſe of a Univerſal Quadrant. Seamans Dictionary, or the Expoſition and Demonſtration of all the parts and things belonging to a ſhip: together with an explanation of all the Terms and Phraſes uſed in the practique part of *Navigation*, by Sir *Henry Manwayring.*

There is lately printed in a portable Volume, exact Tables of Natural and Artificial Sines, Tangents, Secants and Logarithms, and an *Inſtitution Mathematical*, conteining their conſtruction and uſe in the ſolution of all Triangles Plain and Spherical, and the application thereof in *Aſtronomy, Dyalling*, and *Navigation.*

Geometrical Trigonometry, by *J. Newton M. A.* 12. Seamans Secrets.

Seamans Glaſſe, ſhewing the uſe of the Plain Scale in *Aſtronomy* & *Navigation.*

The Compleat Canoneer, ſhewing the principles and grounds of the Art of Gunnery, as alſo ſerviceable Fire-works for Sea and Land.

The Advancement of the Art of *Navigation*, or Seamans Canon of Triangles ſhewing by a new Canon of Sines, Tangents, and Secants how to reſolve all Caſes of right lined Triangles, onely by looking into the Tables, without any Calculation. Particularly applyed to all the three Kinds of Sayling, *viz.* by the Plain Chart, Mercators Chart, by a Great Circle; And to the Art of Surveying.

Trigonometria Britanica, or the Doctrine of Triangles, in *folio*, exhibiting the Logarithms of all numbers from one to a hundred thouſand, in a large Figure and but a few ſheets, the Sines and Tangents to the hundredth part of a Degree, the three firſt degrees to a thouſand parts, with Mr. *Gellibrands* Doctrine of Triangles faithfully tranſlated from the Latin Copy, and an Inſtitution, ſhewing the conſtruction of both the Canons in a more compendious manner then hath been hitherto publiſhed in the Engliſh Tongue.

The Sector on a Quadrant, a Treatiſe containing the Deſcription and uſe of three general Quadrants accomodated for the ready finding the Hour and Azimuth univerſally in the equal Limbe, with an Appendix ſhewing how to make Dials from a reflexive Glaſſe, placed at any Reclination, by *John Collins.*

The Saints Anchor-hold in all Storms and Tempeſts, preached in ſundry Sermons, and publiſhed for the ſupport and comfort of Gods people in all times of Trial, by *John Davinport* Paſtor of the Church of Chriſt at *New-Haven* in *New England*, 12.